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Volume 52, No.3

March 1991

AUSTRALIA'S LARGEST SELLING ELECTRONICS MAGAZINE — ESTABLISHED IN 1922

How Toshiba won the 1Mb DRAM race...

Back in 1981, Toshiba seemed to be lagging behind in memory technology. But by 1990, it had become world leader in 1Mb DRAMs. How this dramatic turnabout took place is explained on pages 124-127.

Historic amateur TV test

Late last year, Aussat helped local amateur TV operators conduct a historic satellite test. See page 28.

On the cover

Launching a satellite with Orbital Sciences Corp's Pegasus booster costs a mere US$6 million, compared with the $200 million or so of a conventional launch via the Space Shuttle. Kate Doolan explains how Pegasus works, in our story starting on page 18. (Picture courtesy OSC)

Entertainment Electronics

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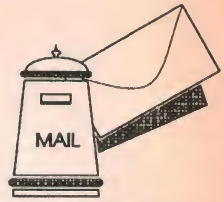
LETTERS TO THE EDITOR



True 'hams'

I refer to the item under 'Amateur Radio News' in December 1990, concerning the demise of *Ham Radio* and the true-brew (home, of course!) radio amateur.

May I suggest that the proud term 'ham' be restricted in future to those amateurs who make their own gear? And that mere button pushers of multi-thousand dollar gear be known as 'Hamcocks'?

The term derives, of course, from that funny — although wildly inaccurate — old episode of 'Hancock's Half Hour' in which Tony was everything that a good 'ham' shouldn't be.

Alan Wright (VK2JOY),
Parkes, NSW.

Wrong apple

I am writing to point out an error in your August issue. The computer shown on page 59 is not an Apple IIC, but either an Apple II Plus or II Europlus.

The Apple IIC is a much newer computer, which is portable and much smaller and more expensive.

Peter Fleischmann,
North Sydney, NSW.

Comment: You're quite right, Peter — it was an Apple II Plus. The editorial face is now the shade of a ripe Jonathon!

UPS and SPS

There appears to be a general misunderstanding in the marketplace between a true no-break UPS and a standby or SPS system.

Unfortunately there are many so-called 'UPS' advertised in the Australian market place which are in fact not true no-break UPS at all. They are the standby or short break types

Although it is possible for a standby SPS to switch over in a time so short that the computer does not respond to the interruption, it is misleading to claim that these backup power supplies are true UPS.

A true no-break UPS by its very design provides complete isolation between its output and incoming mains, and because it recreates its output sinewave it has no transfer time when battery operation is required.

Furthermore its distortion specifications are completely independent of the incoming mains, a feature which is not available with the SPS backup supplies.

The quickest way to find out whether a unit is an UPS or SPS is to look at the product specifications for a transfer time, for example: transfer time = SPS.

When looking for an appropriate power conditioning product for your equipment, make sure you know what you are getting and check with an expert in the field if you are unsure.

Victoria Maule,
Marketing Manager,
Critec Pty Ltd,
Dowsings Point, Tas.

Comment: Thanks for the clarification, Victoria. While from the manufacturers point of view, the difference may be significant, this may not be the case as far as users are concerned.

Chip resistors

It was not until I attempted to obtain the chip resistors for the new VHF Powermatch Mk2 that my problems arose.

To find a retailer that would order the resistors from Crusader was met with a firm 'No'. One agent for Crusader was willing to oblige, the only problem was that their minimum order was one hundred units, and then to sell me four was just not on.

A cry of help to Crusader was met with sympathy and the four resistors were graciously supplied at no cost. The project is approaching completion and I look forward to being able to put it to use.

I had noted in the earlier articles that there may be a little more to come with the project, namely an impedance bridge and a dummy load. This was logical, as it would then completely update the original VHF Powermatch.

Imagine my horror on reading the article — all those chip resistors and the non-inductive potentiometer!

I feel that I cannot go back to the person at Crusader and ask for the components that are now required.

I have rung Jaycar, Rod Irving and your reader service all to no avail. Can you please help?

A great article that has undoubtedly given you a great deal of satisfaction in developing.

Unfortunately I think it remains in the same category as the original project — just cannot be constructed because of the non-availability of specialised components to the average radio amateur.

John Pinson B.Sc., VK2KBD,
Taree, NSW

Comment: Good news, John — Crusader Electronic Components has now made arrangements to supply the components direct to readers. The firm's address is 81 Princes Highway, St Peters 2044; phone (02) 519 5030 or 519 6685.

Ozfi story

I am writing to thank you on behalf of the Ozfi Group for the article you wrote on Australian-made hi-fi, in particular, ME, Orpheus and Audio Definition in the December issue of *Electronics Australia.*

Ozfi, as you know, is a group made up of extremely knowledgeable and dedicated individuals each manufacturing their own brand of hifi product in Australia to the highest standards achievable in this country.

As a group we find that by working together using each other's expertise in the different facets of the industry, we are able to manufacture products that meet or exceed overseas competition, usually at a fraction of the cost.

We feel that it is people like yourself who, by being prepared to give an honest unbiased review of our products, greatly assist us in achieving our goals.

Publications such as yours better create an awareness in the hifi buying public, that the Australian product is generally a more than viable alternative to that of our imported competition.

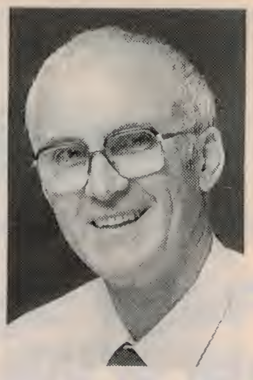
We look forward to giving you a preview of some of our other products in the near future.

Lia Galante, MD,
Audio Definition,
Port Macquarie, NSW.

DROP US A LINE!

Feel free to send us a letter to the Editor. If it's clearly expressed and on a topic of interest, chances are we'll publish it. — but we reserve the right to edit those that are over long.

EDITORIAL VIEWPOINT



High technology and anti-social personalities

Remember the discussions we had last year in the Forum column, about computer viruses? At that time, there were some readers who were inclined to think that the whole subject was a figment of our over-active imaginations. Surely there were no such things, they suggested — if computers crashed, this was almost certainly due to hardware problems. Who on earth would deliberately write programs to make computers crash or destroy files?

Well, since then I suspect there have been enough reports of disasters caused by viruses to convince even a skeptic of their existence and destructive power. From what I've read, there now seem to be many hundreds of known viruses infecting the IBM-compatible family of PCs around the world, and at least 25 of them are confirmed as circulating in Australia. There have been many reports of serious infections, especially at schools and colleges of advanced education.

Perhaps I'm still too much of an idealist (even now!), but I find it sad, that the efforts of a few hundred anti-social programmers have forced us all to become suspicious and security conscious.

When microcomputers and personal computers first became available, there was a wonderful spirit of cameraderie among the pioneering 'hackers'. Just as with the early days of amateur radio, people were happy to help each other by swapping programs and utilities they had written, along with any knowledge they had gained. It was a remarkably friendly and helpful atmosphere, which undoubtedly played a major role in the almost explosive growth of personal computer hardware and software technology.

But now that friendly, open atmosphere has all but gone — destroyed by a relatively small number of stunted and immature personalities, who presumably couldn't resist the temptation to 'show off' their programming prowess, by creating viruses and other destructive software.

I guess it's just another demonstration of the fact that although the human race has the ability to create and develop impressive technology, it also has a nasty tendency to use that ability — and the resulting technology — for destructive ends. All the same it seems a pity that personal computers, with their enormous potential to help in the growth and management of our knowledge, are now tainted with the risk of data trauma.

In this month's Workstation section, you'll find a very informative article on viruses by Roger Riordan, an acknowledged Australian authority on the subject. A former lecturer at Chisholm Institute of Technology, Mr Riordan explains not only how viruses work, but also what you can do to protect your computer(s) from them. I feel sure you'll find it as interesting and helpful as I did, despite the saddening aspects of our having entered the post-virus era.

Jim Rowe

What's New in VIDEO and AUDIO

Philips 'Digital Compact Cassette' system star of this year's Las Vegas CES

The undisputed highlight of this year's Consumer Electronics Show, held in Las Vegas in January, was the demonstration given by Philips Consumer Electronics of its new Digital Compact Cassette (DCC) system, to a group of journalists from many countries. The company also provided further technical details of the system.

At the demonstration, Philips spokesmen stressed that the DCC equipment being premiered was still in the prototype stage. Commercial versions of the system are not expected to be released until next year, so this was really a 'preview' (pre-audition?).

As previously announced, the DCC system uses compact cassettes similar in size to existing standard analog compact cassettes, and is designed to be compatible with them — to the extent that DCC recorders and players will also be able to play back analog cassettes. Philips has done this deliberately, in view of the enormous popularity of the existing analog cassette system, to ensure DCC's rapid acceptance.

However the new cassettes are more rugged, and have a sliding sleeve to protect the tape which would otherwise be exposed in the head/capstan openings — rather like the sleeve on 3.5" floppy disks (see pictures). The sleeve also covers the drive hub holes, making the new cassettes fully self-sealed against dust.

A further feature of the DCC cassette is that it is single-sided, even though the matching decks record and play along both edges of the tape, as with existing analog cassettes.

This has been achieved by making the decks bi-directional, with auto reversing and a 'flip-over' head system. The user is therefore freed from the hassle of having to stop, remove the cassette, flip it over and re-insert it to record or play the second side.

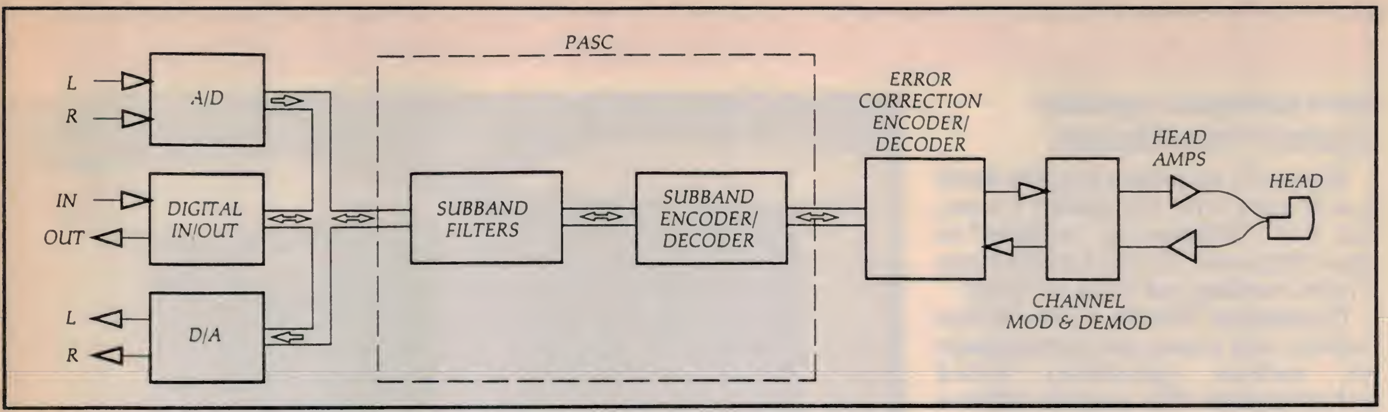
The single-sided nature of DCC cassettes also means that the top surface can carry a printed 'album cover', as on CD and compact cassette library cases. Of course the main feature of the DCC system is that it uses digital recording, to provide the same order of performance and operating convenience as CDs and the DAT system. Yet it achieves this without using the complex helical scanning system used by DAT and video recorders. The tape used is relatively standard chromium 'video' formulation, 3.78mm wide and moving at the same 4.76cm/second used in analog cassettes.

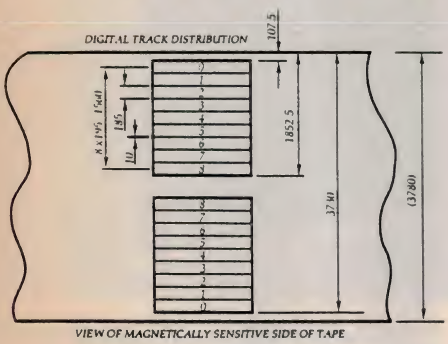
This is achieved by using a nine-track record/play head, fabricated using modern thin film technology. Each track laid and read back by the head is 135um wide, with the tracks spaced 195um apart. Eight tracks are used for the encoded audio, with the ninth for control and auxiliary display information. At the effective audio bit rate of 384bps, the shortest registered wavelength is 990nm (0.99um).

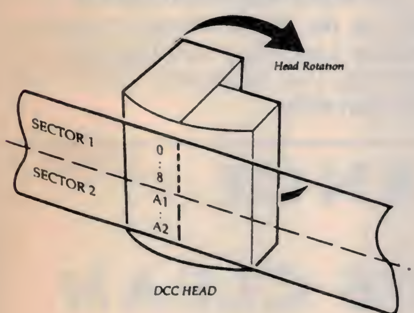
In addition to the nine digital track heads, the flip-over DCC head assembly contains two conventional analog heads for playing standard analog tapes (see diagram).

Like CDs, DCC cassettes offer automatic track finding and user programming facilities. Pre-recorded DCC tapes will feature a table of contents, and track-to-track accessing times are only a few seconds. DCC therefore offers a significant improvement in user convenience, over conventional analog compact cassettes.

DCC recorders and players are apparently designed to operate at any of three sampling rates: the 44.1kHz used







by CDs, 48kHz as used for DAT or the 32kHz proposed for satellite audio transmission. Quoted frequency response for the three rates is 5-20,000Hz, 5-22,000Hz and 5-14,500Hz respectively. Quoted dynamic range for all rates is greater than 105dB, with THD and noise below -92dBandwow/flutter down to 'quartz crystal precision'.

Special encoding

The key to achieving this performance from a fixed head, eight data tracks and a tape speed of only 4.76cm/s, is a special encoding system which Philips calls *Precision Adaptive Sub-band Coding* (PASC).

From the information made available, PASC uses digital filtering techniques to split the audio frequency range into 32 sub-bands of equal bandwidth, which are then passed through a digital signal processor whose performance is modelled on the 'dynamic threshold' behaviour of the human ear. As the signal varies in terms of level and frequency content, the PASC processor dynamically and continuously adjusts itself, allocating the number of encoding bits to each sub-band according to this model. Every sub-band is therefore allocated the number of bits it needs, with those bits not required by particular sub-bands being re-allocated on a dynamic basis to those that do. Philips claims that this allows PASC to provide the highest possible coding accuracy over the entire audio range.

An 'eight to 10' modulation system is used to optimise the resulting data format for recording on tape. Error correction uses the Reed-Solomon C1/C2 coding system.

Although high quality replay of pre-recorded software was an important design goal with the DCC system, Philips has also designed it to allow home recording of similar quality on blank cassettes. The system includes the Serial Copy Management System (SCMS) as an integral part, to limit digital copying of pre-recorded software and thus avoid conflict with software producers.

In view of DCC's inherent low cost and compatibility with analog cassettes, coupled with its ability to deliver full digital audio quality, Philips is confident that it will become as successful as both compact cassettes and compact discs as standardised worldwide recording media. The firm has apparently been developing the system in partnership with Matsushita, Japan's largest consumer electronics manufacturer, and also has the support of major players in the music industry.

DCC manufacturing licences will be offered to all interested hardware and software companies, as was done with compact discs. At CES, Philips announced that the first licensee is Tandy Corporation. ➤

New compact speaker system from Klipsch

Klipsch & Associates has introduced a new entry level loudspeaker system, the KG1. Designed for bookshelf or stand placement, the KG1 is a two-way system standing just 33cm (13") tall.

Components include a new 16.5cm woofer, with a cone and dust cap made of carbon (graphite) filled polypropylene. The graphite additive increases cone rigidity for greater output and lower distortion.

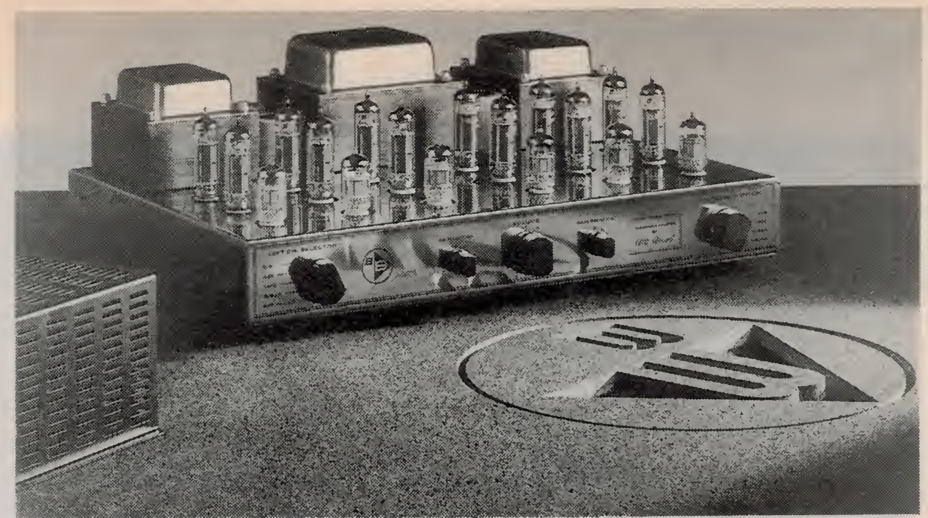
The motor structure of this woofer has a vented coil which increases power handling and output at frequencies below 100Hz.

The system relies on a 'Dhorm' tweeter, the hybrid of horn and dome technologies long used by Klipsch. The tweeter motor is ferrofluid cooled for increased power handling, output and reliability. System sensitivity is 90dB SPL/one watt one metre, with frequency response of 50Hz to 20kHz +/-3dB. Normal impedance is 8 ohms.

The cabinet of the KG1 is offered in oiled wooden veneers of either oak or walnut. Suggested retail price is $950 per pair. Klipsch entered the market in 1946 with its famous Klipschorn, which is still available today and considered the 'benchmark' by audio engineers.

For further information please circle 200 on the reader service coupon or contact Legendary Loudspeakers, PO Box 206, Port Melbourne 3207; phone (03) 646 6956.

Beard amplifiers now in Australia



The name Bill Beard is a name well known to many British audiophies, with many credits to his name in the design of tube pre and power amplifiers including the classic P100 amplifier.

More recently Bill left Beard Audio after an association of some 12 years to form a new company, called British Built Audiophile Products (BBAP). Beard contends that although his new products will differ in many ways from previous designs, he will continue in the tradition established by such classics as the P100.

Thus the introduction of the PB100, a 50 watt/RMS, single chassis integrated amplifier now available through Australian importer Kedcorp. The new amp boasts some 18 valves, 12 of which are EL84's — three pairs per channel in parallel push pull.

The rest of the valve compliment comprises four EDD81's (12AT7), and two ECC82's (12AU7), the ECC81 being employed in the driver stage and as a phase splitter and the ECC82 as a cathode follower.

All the tubes in the BB100 (18 of them) are fully DC regulated — a new departure from just applying DC only to the more sensitive front end tubes. Beard contends that this approach attributes to the BB100's claimed total absence of any background tube noise.

Beard claims his output transformers are wound and constructed to within 1% tolerance and are tapped at the 35% ultra-linear tappings and as a result are understressed and require less feedback.

The power supply section offers 1300uF reservoir capacitors for each output stage, and each driver stage employs its own dedicated DC power supply of 4700uF per channel.

The BB100 is available in either gold or chrome finish (gold finish slightly more expensive) and is covered by a two year parts and labour warranty (one year warranty on tubes). A phono module will shortly be available. RRP is $5295.

Further information is available from Kedcorp Pty Ltd; (02) 708 4388. ■

The Challis Report:

PIONEER CT-M6R MULTI-CASSETTE CHANGER

Ever astute in spotting a significant potential market, Pioneer was the first to develop a multi-disc CD player. Now the same firm has developed a six cassette tape recorder/player, which look likely to set another trend. Louis Challis has been putting the unit through its paces.

It was back around the year 1971 when I last reviewed a multi-cassette changer. That particular cassette changer had been designed by Philips at Eindhoven and was regarded as 'avant-garde' by their marketing personnel.

The cassette changing mechanism used what they described as a 'Ski Ramp' system and as I recall, I viewed it as being a relatively complex system with a degree of reliability which left something to be desired.

I have strong recollections of having panned the unit, primarily because of its perceived mechanical problems and it is interesting to note that Philips subsequently withdrew the cassette changer from the market a short while later. In the ensuing period, whilst there have been a number of commercial multi-cassette changers or players developed, surprisingly there have been relatively few (if any) units developed for the consumer market. It must be just as obvious to you, as it was to Philips 20 years ago, that there is a sizable market for such equipment, so one could be excused for asking why has it taken so long for an enterprising manufacturer to fill a breech which was clearly evident 20 years ago.

Now the Pioneer Electronic Corporation of Japan has an enviable reputation for developing innovative and practical hi-fidelity products. Its development of the PD-M40 multi play compact disc player and subsequently the PD-M430 to PD-M730 series of later derivatives of the multi play compact disc players, has extended the market for CD players appreciably.

Now surprisingly, in the ensuing period, following the development

of the PD-M40, most of Pioneer's competitors have released what can best be described as a series of 'me too — look alikes', because of the very positive market response and general acceptance of the multi play compact disc players.

The new CT-M6R multi-cassette changer is in practical terms directly comparable with the PD-M40 series and PD-M430 series multi-play compact disc players.

It provides the capability of loading six conventional compact cassettes for sequential unassisted continuous playing — or should you wish, for sequential and unassisted automatic recording, (provided the appropriate CD source and special control cable is connected).

The real attribute of the CT-M6R multi-cassette changer is the degree of ergonomic convenience which it affords the intending user, and I have no doubt that the CT-M6R sets the ground rules for the next generation of 'me too look alike' multi-cassette changers, which will hit the market in 1992.

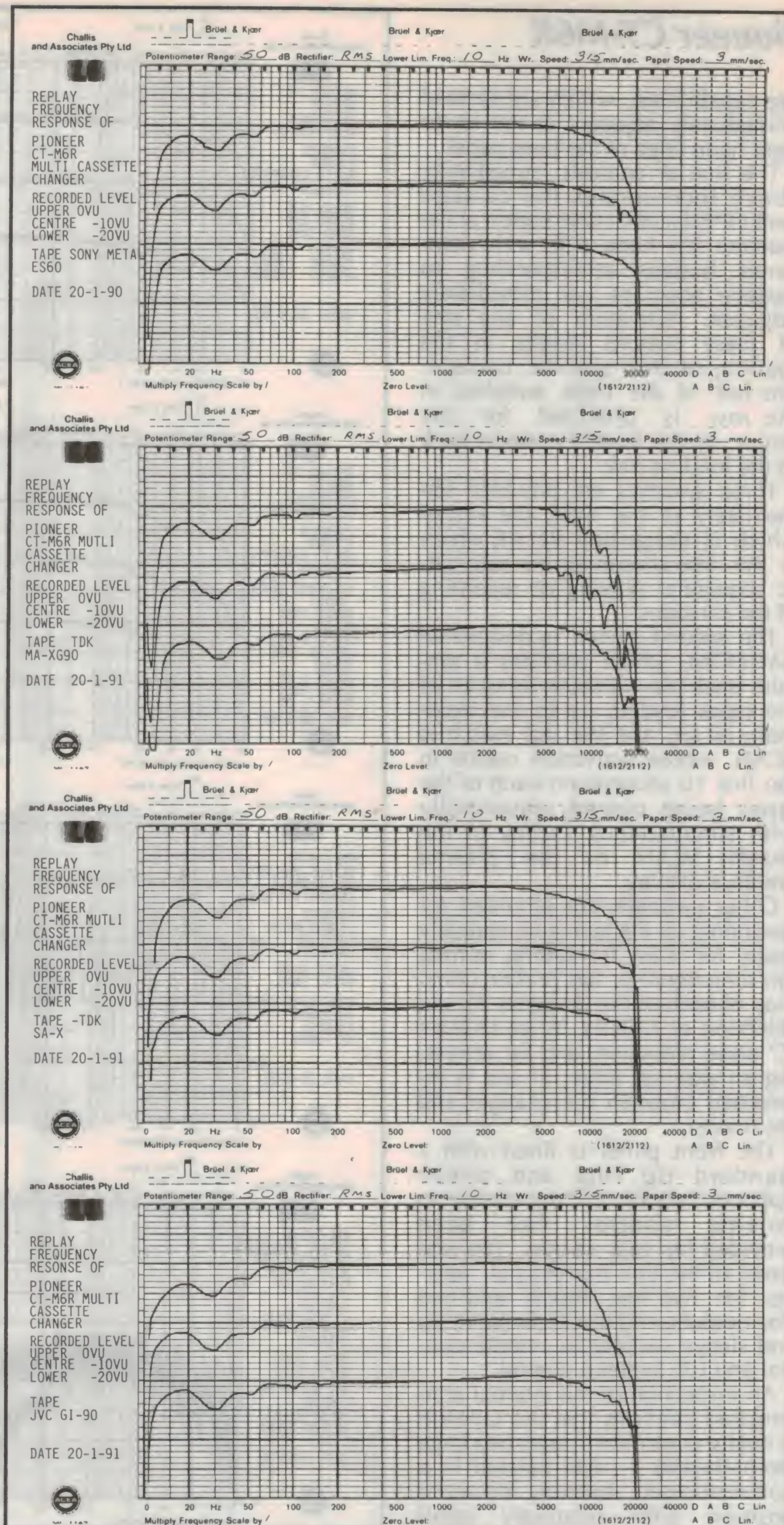
The CT-M6R has many really nice features, the most important of these being its simple tray loading system, which even lay-people should take in their stride.

This is activated by the OPEN/CLOSE button on the front on the front of the deck. The designers have also taken the trouble to provide a series of sensibly designed push buttons and switches, which are supplemented by a particularly convenient and effective infra-red remote control.

As I soon discovered, the large plasma display panel provides comprehensive and readily assessible graphic information on the operational condition and settings of the multi-cassette changer and the six cassettes which have been loaded.

An examination of the front panel reveals that the primary controls are contained in five groups with the main and most frequently used functional controls, STOP, FORWARD PLAY, REVERSE PLAY, FAST FORWARD AND FAST REWIND at the lower edge of the front panel.

The second most frequently used set of controls are those provided for RECORDING MUTE, PAUSE, RECORD and the CD SYNCHRO button (requiring a CD player specially equipped to provide match-



The replay frequency response obtained from the Pioneer CT-M6R multi cassette changer with four different tape formulations, and in each case, at three different recorded signal levels.

Pioneer CT-M6R

ing capabilities), which are located immediately adjacent at the lower right hand edge of the front panel.

The line of controls immediately above incorporates the cassette well OPEN and CLOSE button at the extreme left hand side with numbered buttons corresponding to cassette positions 1-6 immediately adjacent. Activation of any one of these buttons results in the loading of that specific cassette. The last of the eight switches in the row is provided for the return of the loaded cassette back to the loading tray.

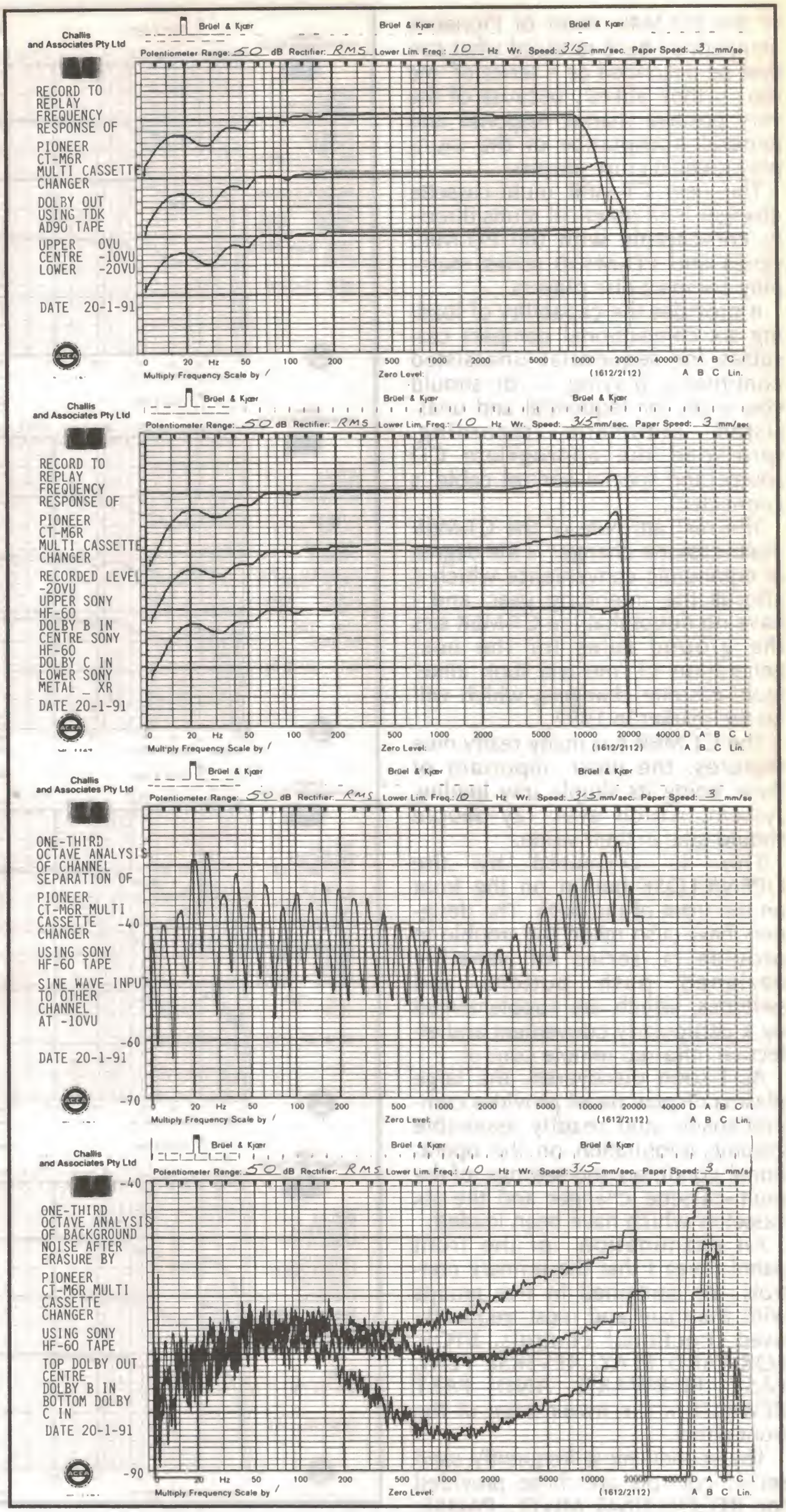
Three switches are provided immediately to the right, the first of which is designated RELAY, which is the title chosen for the automatic sequential playing or recording of the six tapes.

The second switch is designated RANDOM, which provides a random track play function using all of the tapes loaded, up to the maximum of six; and the last switch is SCAN, whose activation results in the first 10 seconds on each of the tapes being played sequentially with simultaneous display of the words SCAN or the plasma graphics display.

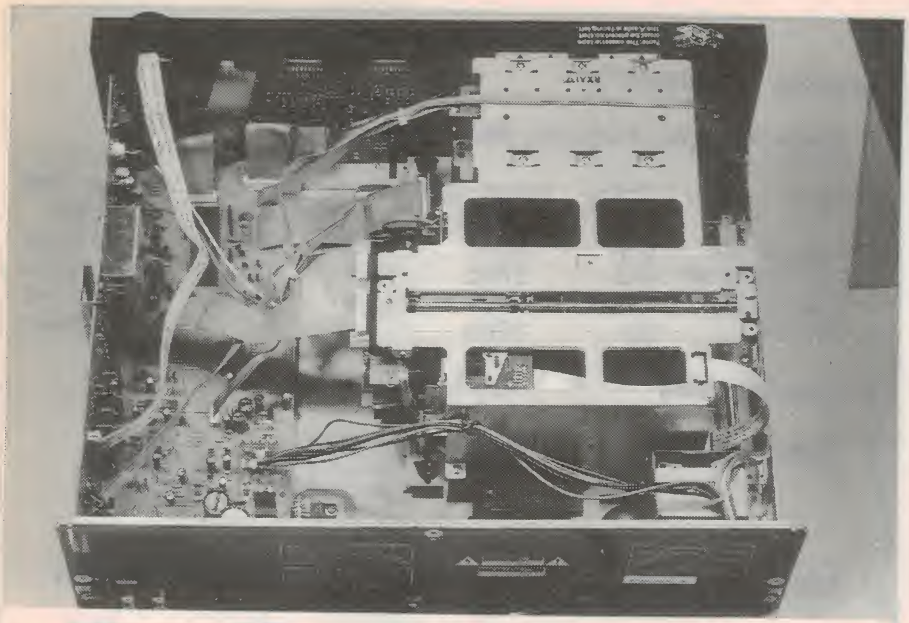
Other switches are provided for rewinding all the tape automatically ready for play, for setting normal uni-directional or full bi-directional play of each of the six tapes, for the selection of DOLBY 'B' or DOLBY 'C' noise reduction, and for activating an external timer, (if one is interposed between the changer and the mains).

The front panel is fitted with a standard tip ring and sleeve ('phones') socket, but regrettably no volume control has been provided for that socket. The rear panel of the unit has coaxial sockets for two line inputs and two line outputs, and three miniature tip and sleeve sockets for remote control and CD Synchro control.

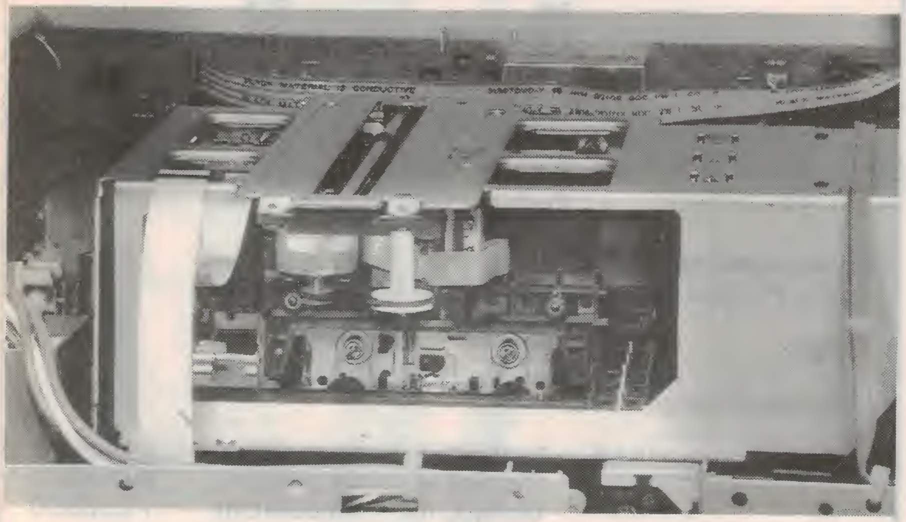
An inspection of the internal construction confirms that the CT-M6R is neatly constructed, with two large motherboards — one located in a conventional bottom mounted position with relatively small numbers of transistors, but some rather significant special LSI chips and a number of normal dual in-line chips.



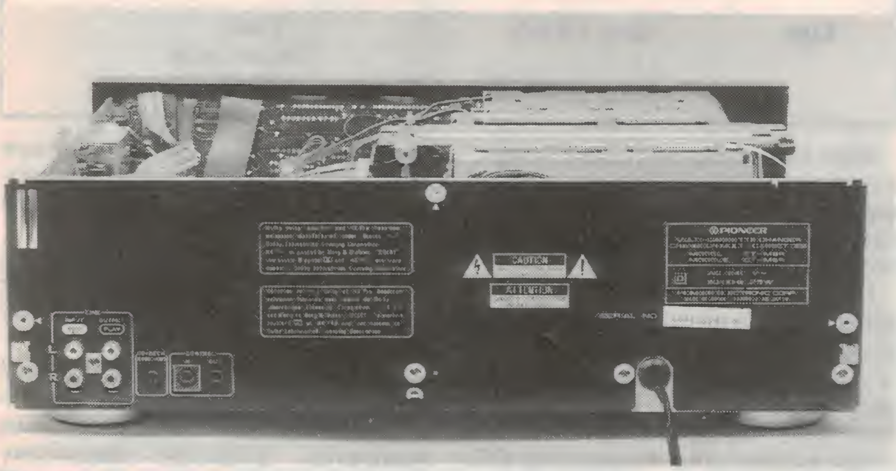
At top are the record to replay frequency response curves for the changer, first with the Dolby out and then for Dolby 'B' and 'C' operating respectively. Below these are the curves for channel separation and background noise after erasure.



Above: An overall view inside the changer with the two main PC boards on the left and the changer mechanism on the right.



A closeup looking in from the side of the changer mechanism, showing the vertically mounted tape deck just visible under the transport mechanism.



There isn't much at the rear of the changer, apart from the audio input and output connectors at lower left with the control input and output jacks alongside.

The second comparably sized motherboard is located vertically on the side of the chassis, and provides the music search HP amplifier, Dolby playback amplifier and Dolby HX amplifier, as well as the recording amplifier and bias oscillator circuits.

These are neatly interconnected by simple direct wiring and some unusual parallel ribbon feeder cables, with plug and socket connections to simplify manufacture, servicing and maintenance.

The front controls and display module are directly connected to a third printed circuit board all neatly interconnected with ribbon cables. My major reason for opening the cabinet was of course to examine the cassette drive and its special loading system.

The mechanical system is particuarly neat in its operation, and uses a series of ingenious slide elements to withdraw the specific cassette selected, plus a separate motorised transverse loading arm system to insert the selected cassette into the cassette drive.

This composite loading and drive system is based on a solidly constructed metal box chassis, and it appears to be both ruggedly and sensibly designed and executed.

Test results

Objective testing revealed that the replay frequency response of the changer is quite good.

Using our type '1' test tapes, the frequency response extends from 37Hz to 13kHz, +0/-3dB. The test with the type '2' test tapes revealed that the replay frequency response is even better, extending up to 16kHz at the -3dB point, but no better with the metal test tape, as the frequency response is dominated by the accuracy of azimuth alignment of the CT-M6R.

The 'record to replay' frequency response of the changer is particularly good on each of the three tape formulations — significantly better than Pioneer claims in its literature. (In case there is any misconception, the specific machine which I evaluated was a stock machine, which had not been prechecked by Pioneer's service personnel).

The frequency linearity over the critical frequency range from 60Hz to 10kHz is exceptionally smooth and this frequency linearity is com-

parable with the performance provided by my previous generation of instrumentation recorders.

The measured signal to noise ratio performance is reasonable, but not outstanding when the noise reduction systems have not been activated. However it is significantly better than 67dB(A) with Dolby B, and improves to 73dB(A) with Dolby C, relative to the 3% third harmonic distortion level at 333Hz.

The wow and flutter figures are reasonable at .08% weighted RMS. This is marginally higher than claimed in the manufacturer's literature.

The distortion figures are particularly good at medium and low frequencies, but moderately high at high frequencies.

Taking into account the type of tape drive system and its incorporation of a six cassette changer mechanism, the electrical performance of the changer is impressive.

Listening tests

In order to evaluate its technical performance and overall musicality, I loaded the changer up with a series of six recently released prerecorded cassettes. This was both to assess its overall performance, and most particularly when the special functions including 'RELAY' and 'RANDOM' were activated.

The most impressive of the cassettes that I used were Mozart's 'Requiem', with Carlo Maria Guilini (Sony Classical Chrome tape ST-45577), and John Williams conducting John Williams 'The Star Wars Trilogy' (Sony Classical Chrome Tape ST 45947).

These really brought my music system to life and provided sound quality which is significantly better than I would expect from a 'background music system', almost approaching the performance of a compact disc.

The only intrusive feature of the changer was the low level whirs and clunks that the mechanism made as it loaded and transferred a cassette into the internal cassette drive.

Once loaded the changer makes no perceptible noise whatsoever, excluding of course, the amplified sounds out of the music playback system.

Measured Performance of Pioneer CT-M6R

Serial No: KD8600097N

1. **Record to Replay Frequency Response at -20VU**

Tape	Dolby	Lower -3dB Point	Max Point and Frequency		Upper -3dB Point
Sony HF-60	B In	38Hz	+3dB	16kHz	17kHz
Sony Metal-XR	Out	37Hz	+1.5	20kHz	above 20kHz
TDK AD90	Out	35Hz	+3.0	17kHz	20kHz
TDK SA-X	Out	37Hz	-	-	20kHz

2. **Speed Accuracy** +0.6%

3. **Wow and Flutter**

Wow	Average	0.08% P-P
Flutter	Unweighted	0.14% RMS
	Weighted	0.08% RMS

4. **Harmonic Distortion**

		100Hz	1kHz	6.3kHz
0 VU	2nd	51.1	50.5	45.3
	3rd	58.2	48.5	41
	4th	-	52.4	-
	5th	-	51.6	-
	THD	0.3	0.6	1.1
-6 VU	2nd	50.6	49.3	42.1
	3rd	56.0	48.5	38.8
	4th	-	48.3	-
	5th	-	47.3	-
	THD	0.33	0.79	1.4

5. **Maximum Input Level**
(for 3% third harmonic distortion at 333Hz)

Tape		
	Sony HF-60	+8.5VU

6. **Dynamic Range**

Tape				
	Sony HF-60	Dolby Out	49.0dB(Lin)	55.5dB(A)
		Dolby B In	59.0dB(Lin)	69.0dB(A)
		Dolby C In	61.5dB(Lin)	73.5dB(A)

7. **Erasure Ratio**
(for 333Hz signal recorded at 0 VU)

Tape		
	Sony HF-60	70dB Below noise
	Sony Metal-XR	70dB

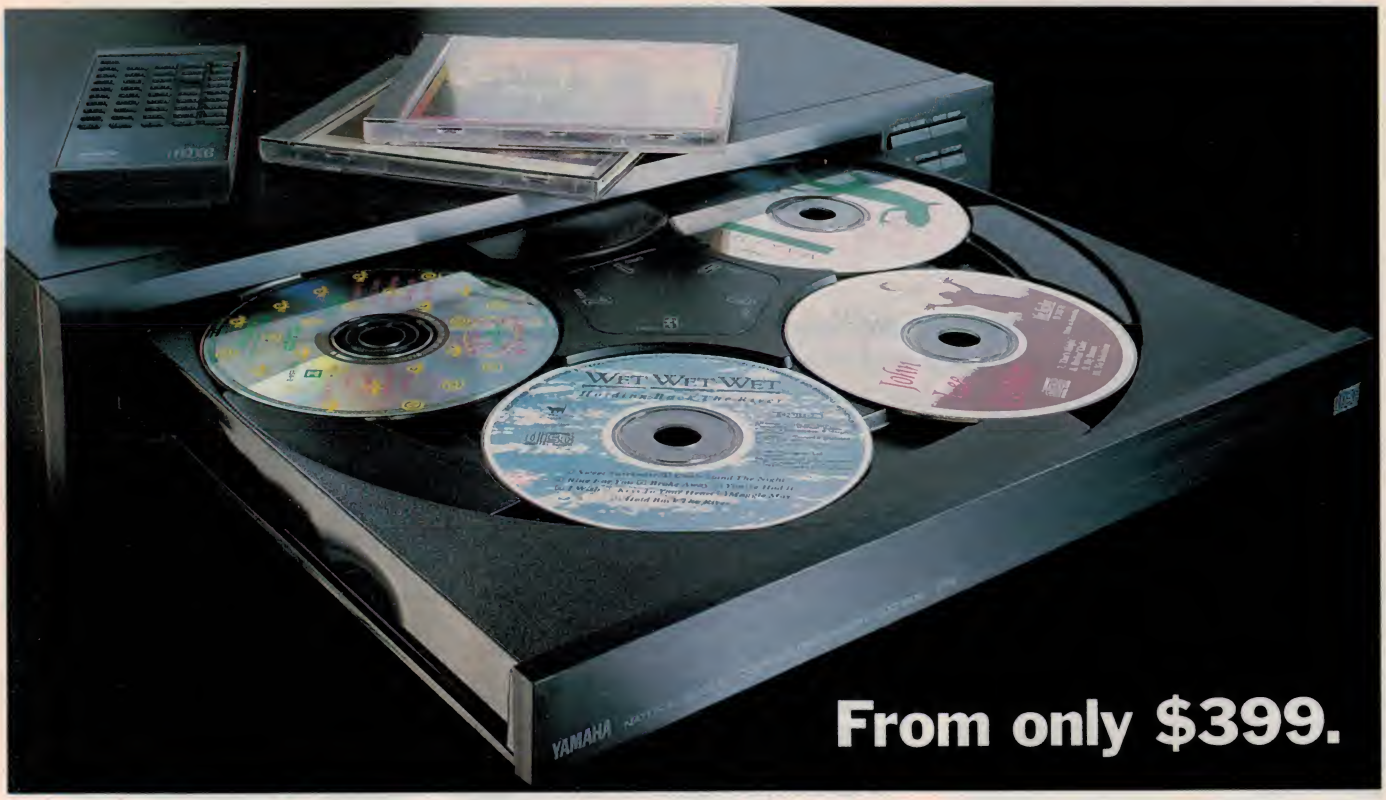
After two weeks with the CT-M6R, I have started to change my point of view that only a multi-disc player can replace my long since departed record changer.

I believe that the CT-M6R is a potential contender for those people who prefer cassettes to CD's and particularly where they wish to play the same music in their car (or boat) that they play at home.

For background music, the CT-M6R offers not only a logical alternative, but based on my observations it is potentially more convenient than many of the multi-disc CD changers currently on the market.

Dimensions of the CT-M6R are 420 x 372 x 136mm, and it weighs 7.5kg. It has a recommended retail price of $699.

For further information contact your nearest Pioneer stockist, or alternatively, Pioneer Electronics Australia, 178-184 Boundary Road, Braeside 3195; phone (03) 580 9911. ■



All CD changers change your music. Ours let you change your mind.

It's not really surprising that CD changers have become so popular so quickly. After all, why buy a player that plays one CD when, for about the same money, you can have one that lets you choose from five?

The trouble is, with cartridge CD changers, you're stuck with the discs you put in the cartridge. And with 5 disc top loaders, where do you put your turntable?

The problem's solved by the stackable Yamaha carousel system with Play x Change.

You open the drawer, as you would with a normal CD player, load 5 discs into the carousel and press PLAY.

Now, suppose you're halfway through that first disc and you want to change the second one. Or the third. Or all of the other four.

Just open the drawer and make the change. While the CD that's already playing, keeps playing.

In a nutshell, that's how our carousel players work. How they sound is every bit as impressive, thanks to S-bit Technology.

So is the price. The CDC-615 is $399 rrp. Including infrared remote control, random play and disc-to-disc random play.

The Yamaha CDC-705 ($499 rrp) and CDC-805 ($699 rrp) are even more sophisticated.

In fact the 805 is the only changer with a built-in Digital Equalizer. Five programmable digital pre-sets give every type of music even more presence.

What's more, you can programme and store your EQ settings for a total of 100 compact discs. And just in case a changer that plays 5 CDs in a row isn't enough, the 805 can be connected to another 805 to play 10 discs.

Or as much as 12 continuous hours of music.

Extraordinary though all this technology may be, it's also extremely reliable. Which is why all three models come with our 5 year warranty (1 year on the laser mechanism).

You can see and hear them at your Yamaha dealer.

And once you've done that, we think your mind will be made up.

YAMAHA

WITH 5 YEAR WARRANTY.

Booth & Mier YAM 037/R

READER INFO NO. 4

PEGASUS: Wings into space

Up until last year, there were only two ways to launch a satellite into space — both of them costing around $200 million. But a third and much cheaper method is now available, the brainchild of a company started only 10 years ago by three Harvard graduates.

by KATE DOOLAN

One of the more prohibitive barriers for any country or organization hoping to launch their own space payload has always been the high cost of either buying or building a launch vehicle. Whether the launch takes place aboard an expendable launch vehicle or from the payload of NASA's Space Shuttle, the costs of a launch can run up to $200 million and success is not always guaranteed.

Now, only three years after its conception *Pegasus* has become the new alternative to using expensive launch vehicles. Developed by the Orbital Sciences Corporation in the United States, Pegasus can deploy a satellite or payload into low Earth orbit for approximately six million dollars.

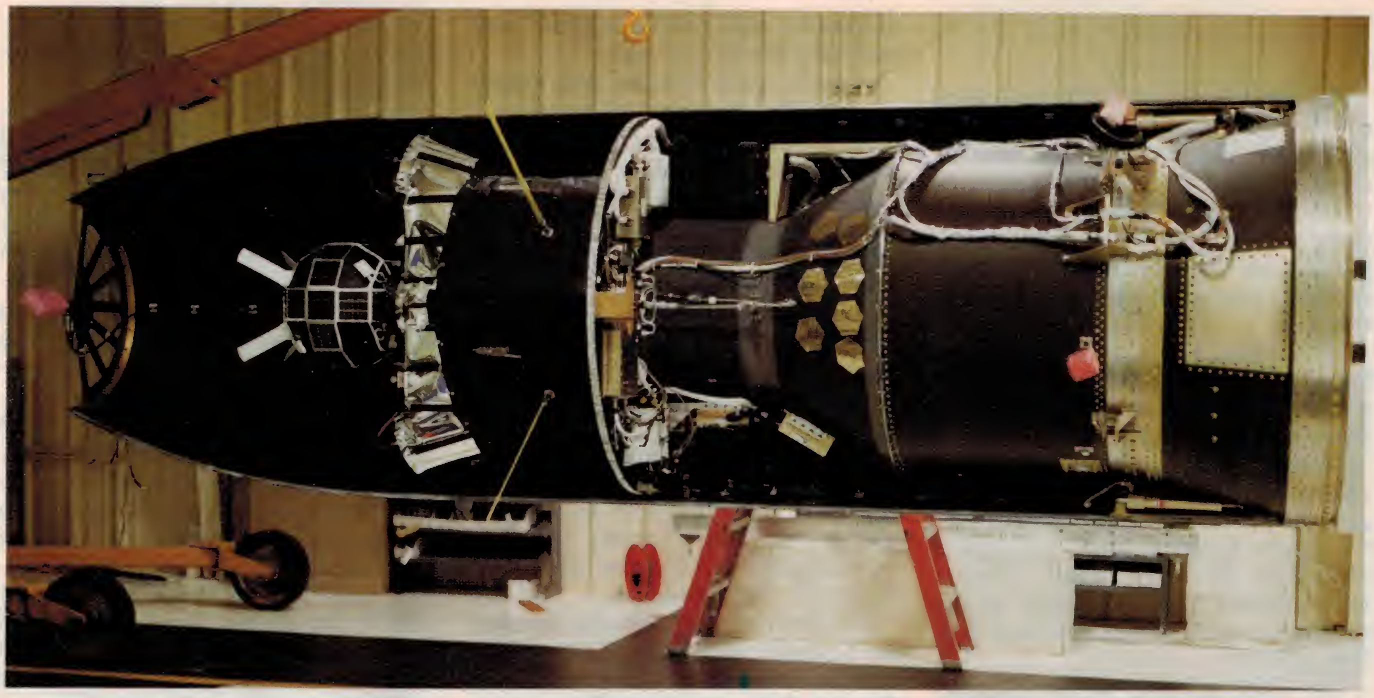
Orbital Sciences Corporation is the brainchild of three Harvard University graduates who met in 1981 — David Thompson, Scott Webster and Bruce Ferguson.

With the opportunities opened by the first launch of the shuttle in 1981, the three decided to pool their talents and form OSC.

Raising money from a variety of sources, the three men approached NASA with a design for an upper stage booster for the shuttle called the Transfer Orbit Stage. But they were turned down in favour of the liquid-fuelled upper stage, the *Centaur* — which was eventually cancelled as a safety risk following the Challenger accident in 1986.

Working on a suggestion of an OSC employee, the Corporation decided to build a low cost launch vehicle to capitalise on the opportunities opened

The official rollout of the Pegasus booster at Hercules Aerospace facility in Magna, Utah.



A cutaway shot of Pegasus showing the first flight payload. Visible at left is the NASA satellite known as 'Pegsat'.

after the *Challenger* accident when the shuttle was taken out of the satellite launch market. The vehicle built would hopefully be able to launch satellites and other payloads into space on a regular basis.

The Pegasus booster is 49 feet long, with a diameter of 4.2 feet and weighs 41,000 pounds. Pegasus was designed to launch 900-pound payloads, which are a maximum of six feet long and three and a half feet in diameter into low Earth orbit.

Pegasus has a clipped delta wing with a 22-foot span. The wing, which weighs less than 600 pounds and eight inches thick is designed to carry more than 100,000 pounds of aerodynamic loads during the maximum pull-up stage — which occurs at a speed of Mach 2, 15 seconds after ignition.

Pegasus has three all-moving fins on the aft end of the vehicle, which is the only aerodynamic control surface. These control the vehicle in three axes during the first stage burn.

Powered by three solid fuelled engines, Pegasus' first stage motor has a fixed nozzle; but the second and third stages have moveable nozzles that can be gimballed for directional control of the vehicle.

The seal in the second stage which enables the nozzle to be flexed is the same as the one used in the MX missile, while a smaller version is used in the third stage motor.

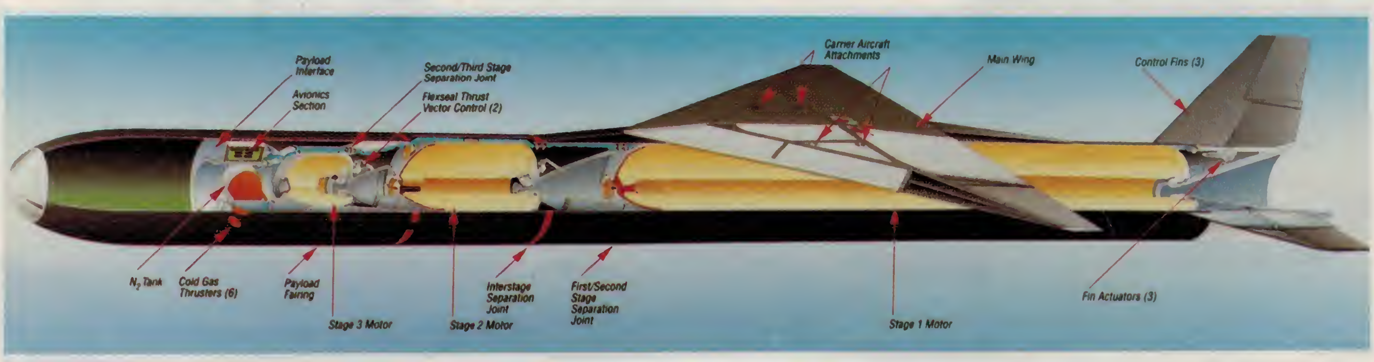
The two-nozzle thrust vector control systems use the same control electronics, providing increased commonality of vehicle components.

Cold gas thrusters at the front of the vehicle provide roll control during the second and third stage burn and control all three axes during the 'coast' periods that occur during operation of the first and second, then second and third stage motors. The thrusters can also provide, if required, orientation or spin following orbital insertion.

There is a forward fairing that covers part of the third stage motor as well as the payload. The fairing is designed to be separated from the vehicle under a variety of conditions, including from zero gravity or at the end of the second burn when the vehicle is experiencing eight times the force of gravity.

One of the highlights of the Pegasus, especially its electronics systems, is that it uses subsystems that are already in mass production — cutting down further on development costs.

The flight control system used by Pegasus is the same as a fire control system used in American tanks and the guidance system was originally developed for the US Navy's *Mark 48* torpedo.



Another cutaway view of Pegasus, with many of its components identified.

Pegasus

For avionics, the OSC designers chose a distributed system comprising 15 microprocessors scattered through out the vehicle.

The main flight computer communicates with these through a bus, comparable to a system used to link a computer terminal to a mainframe system.

By using this system, the designers have lowered the cost of integrating a complex avionics system, and also made it easier to test.

Again, staying with the designers' wishes that the Pegasus be built from as many off-the-shelf parts as possible, the motor ignition, stage separation and flight destruct (abort) systems were adapted from the design of the same systems for the *Peacekeeper* ballistic missile.

The final assembly of the Pegasus booster currently takes place at the Edwards Air Force Base in California, with production currently geared towards building one booster a month. However if the needs of customers change, one booster a week can be built.

But the most unusual difference between Pegasus and a conventional expendable launch vehicle is its means of launching. Instead of launching vertically from a stationary launch pad, Pegasus is currently launched *horizontally* from under the wing of a B52 bomber. In the future it could be launched from a conventional jet liner or cargo plane.

Formerly used to launch the X15 rocket plane in the 1960s, the B52 was used for the test flights and Pegasus' first launch.

The test flights for Pegasus took place in late 1989 and were the first time that the booster had been airborne. The first test flight was to verify the operation of all of Pegasus' guidance, navigation, control and telemetry systems, on both

Pegasus itself and the B52 carrier aircraft. The Pegasus booster was almost identical to the orbital vehicle, but had inert propellant rockets that could be ignited. Full-scale models of the first Pegasus payload were also included, to simulate the satellites to be used on the first launch.

The second test flight was almost identical to the first, but with several differences. The flight followed the path that the first launch would take and flew the mission flight profile up to the point of releasing Pegasus.

Several communication problems were experienced between ground control and the carrier aircraft, but these were considered minor and were fixed in time for the first launch.

The first launch of Pegasus occurred on 5 April 1990. The B52 carrier aircraft, piloted by former astronaut Gordon Fullerton, was flown away from populated areas to 60 miles off the Californian coast and then to an altitude of 43,000 feet.

After checking weather reports, pilot Fullerton then pressed the release button that saw Pegasus drop 350 feet away from the B52 aircraft before its booster was ignited.

Pitching up sharply, Pegasus eventually climbed to 232,000 feet and a speed of Mach 8 before the first stage burnout. Stages two and three then pushed the payload section to just over three hundred miles, where the payloads were released.

One of the satellites launched was a Navy communications satellite and the other was a NASA scientific payload that would release barium chemicals over Canada, to study conditions in the Earth's ionosphere and magnetosphere.

Another part of the NASA satellite, known as *Pegsat*, were several scientific instruments to study and measure launch and spacecraft vehicle altitudes, temperatures, pressure, structural loading and vibrations.

With the emergence on mini satellites in the space market, Pegasus will be very busy over the next couple of years launching up to (at first) four to six missions a year. There will probably be more after that to keep up with demand.

At this stage it is expected that Pegasus will eventually be launching *weekly* by 1995, to provide another alternative to conventional rockets.

Pegasus is also seen at this stage to be the best chance for colleges, universities and other small organizations as their best chance to get into space on a regular and cheap basis (at least in space terms).

Another long-term client of Pegasus will be the United States Department of Defence, which has bought several Pegasus boosters to launch satellites as well as experiments for the Strategic Defence Initiative ('Star Wars').

These experiments are expected to be in the laser field, and as such very little of the results will be released.

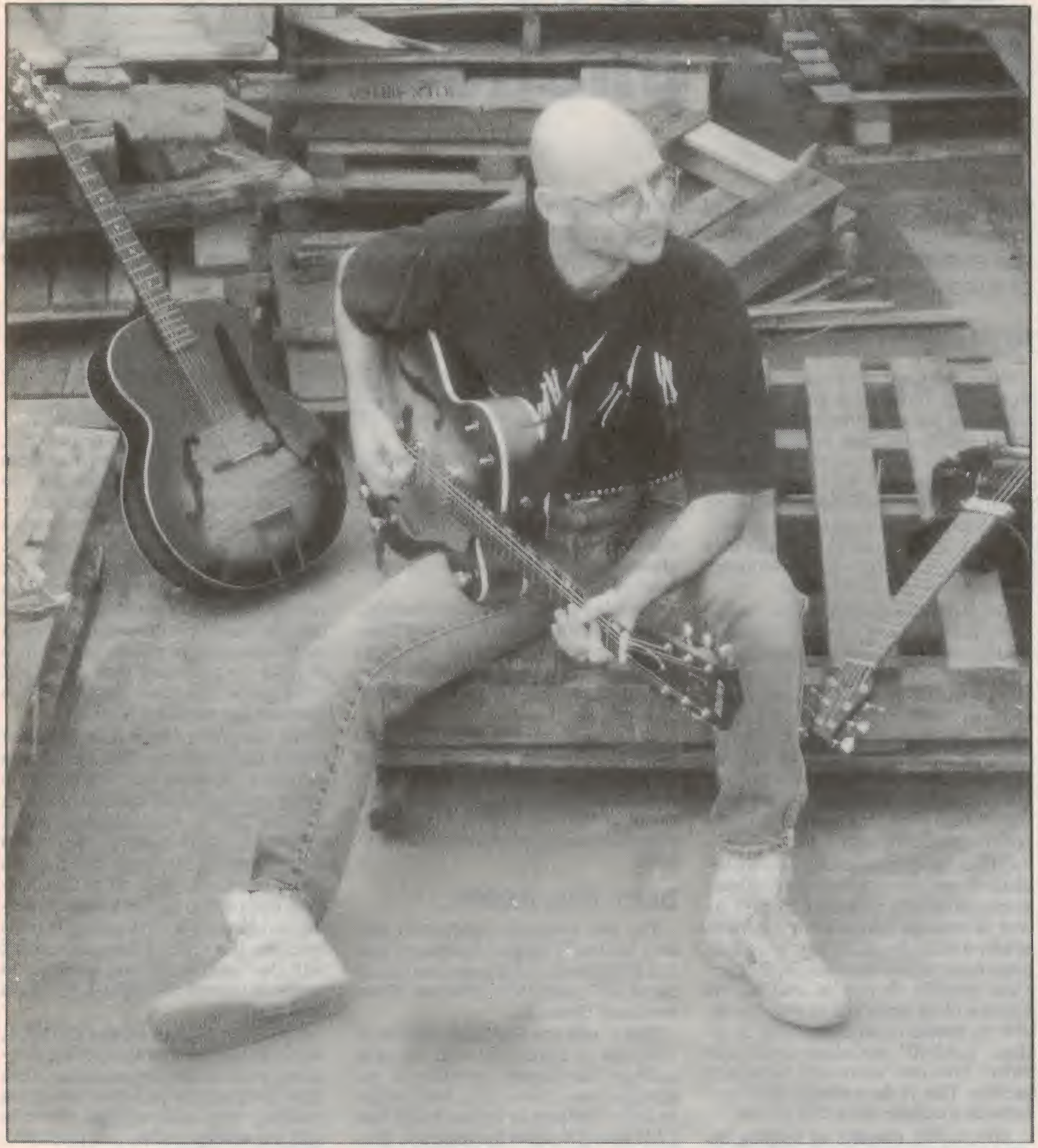
Apart from Pegasus, the Orbital Sciences Corporation will after all be building the Transfer Orbit Stage for NASA, to launch planetary payloads — including the *Mars Observer*, due for launch in the next two years.

OSC is also in the process of building other rockets, tracking and data systems — and possibly in the far-off future, a vehicle that will enable tourists to spend a weekend in space, for less than $50,000!

But in the near future, Pegasus will be continuing to launch satellites. And in the space business, where success is measured by the large size of boosters and expense involved, the meaning of the term 'good things come in small packages' has taken on a new meaning with its successful design and launching. ■

A ground view of Pegasus under the B52 carrier aircraft.

SONICS



The Australian magazine for music makers

Technology Update:

'Spread spectrum' cellular phones

One of the beneficial effects of all the recent hoop-la about restructuring our telecommunications systems is that the decision to introduce a second and third cellular telephone operator into Australia has already been substantially delayed. This might well give us the opportunity to take advantage of a promising new technology.

by STEWART FIST

Given the Clayton's level of competition being introduced into the fixed telephone network, the current delay might well be the main achievement of Labor's very-public ideological crisis. Australia may now have a chance to leapfrog a few intermediate stages of development, and get true mobile telephony right in one hit — rather than pass through interim non-evolutionary stages like the rest of the world.

The Australian mobile phone debate really started over CT2, the 'Telepoint' pocket-portable concept imported from the UK, which was aimed at giving city pedestrians all the limited functionality of a coin-in-the-slot phonebox. If you are within 100 metres or so of a Telepoint base station, you can call out (but not receive calls) on your low-cost CT2 pocket phone, although you can use them within your own home or office to both initiate and receive calls.

CT2 is cheap in service costs also, because it connects to the current fixed network and doesn't need much extra in the way of network infrastructure — which is why it lacks the ability to receive calls away from its own base-station. CT2 services provide no way of tracking the location of its users, and so they are unable to handle incoming calls or to initiate 'hand-off' procedures if the user moves from one 'micro-cell' location to another. This is the essential difference between a cellular and a CT2 service.

Also, in the interests of keeping the CT2 handset simple and cheap, the decision was made in the UK to stay with bandwidth- wasteful *frequency division multiple access* (FDMA) radio techniques, and to use an off-the-shelf 32 kilobit/sec adaptive differential (AD) PCM coder for the voice, even though 16kbps vocoders were available.

It has been known for a long time that *time division multiple access* (TDMA) is preferable for digital mobile telephone operation, because time-division restricts the co-channel interference and allows more users to share the same bandwidth.

For this reason, all cellular manufacturers around the world have been unanimous in accepting that the next generation of phones would use time-division digital techniques. The question is: which one?

In the running were four main contenders — two best suited to the larger cellular systems for vehicles and wider-roaming in the suburbs, and two for the small 'micro-' or 'pico-cell' inner-city pedestrian and intra-office pocket portables.

DECT, PCN, DAMPS...

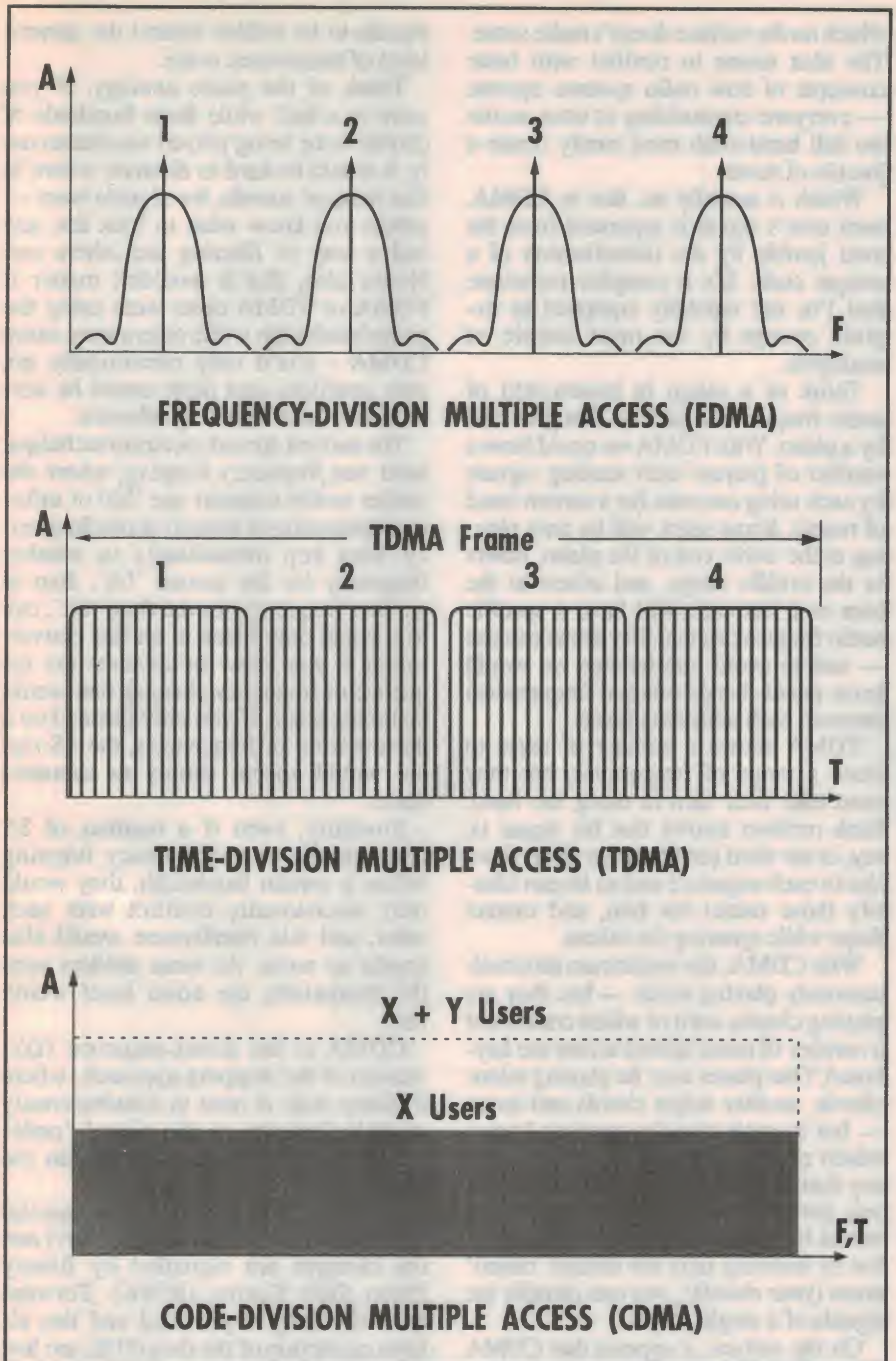
The two intra-office/pedestrian systems are DECT (Digital European Cordless Telephone), which is also incorrectly called CT3, and PCN (Personal Communicator Network).

DECT was the European answer to CT2, but is digital and with two-way calling. The primary intention of the designers was to use radio links within an office complex to replace PABX and LAN wiring systems for voice and data. But as a secondary function, they extended DECT's operations out into the streets with public base-stations, and provided for location tracing, authentication and billing procedures just like cellular.

DECT is due for release in late 1991 or early 1992. It is a low- power, pico-cell, digital system with small handsets having an in-built LCD pager and the ability to transmit computer-data and fax as well as voice. Normally, the handset would sit in a charging unit on your desk and operate like a normal phone, linking by radio to your office PABX. But when you go to lunch or go home, you will take the handset with you and remain contactable always on the same office number — provided that sufficient 'intelligence' has been introduced into the fixed line telephone network.

The low power output of most pocket phones limits their use from vehicles on the move. However the designers have anticipated that DECT can also provide a 'satellite' link to more powerful public and private cellular units. You may be 50 metres away from your car, but the DECT hand-held will act as the last-stage link back to the car's more powerful cellular unit. The planners also anticipate that trains, busses and aircraft will also provide satellite services, to enable you to make outgoing DECT calls from your seat.

PCN is the English version of DECT, which is attempting to advance the technology even further and overcome some of the compatibility problems inherent in matching large-scale cellular networks with the smaller micro- and pico-cells. PCN may use GSM cellular technology (see below), which would make it compatible with the pan-European mobile network, but the latest news seems to be



Frequency division, time division and code division systems of multiple access compared. As the number of CDMA users grows, the noise level simply increases.

that they are branching out on their own. We should see PCN in 1993, which means that it will be a hot competitor to DECT.

With the higher-powered mobile cellular systems, the Americans are developing Digital AMPS (DAMPS), which is a digital version of Telecom's current MobileNet. DAMPS is supposedly able to provide 3-4 times the present capacity over the same bandwidth, and to allow a fairly seamless evolution without replacing the current base-station transmitters. The present analog AMPS and the new DAMPS can co-exist, using most of the same base-station equipment.

...and GSM

Clearly the leader at the present moment, however, is GSM (Groupe Speciale Mobile) which is the pan-European cellular standard. It is similar to DAMPS, but perhaps more complex and sophisticated. GSM uses time-division techniques which allow eight users to share the same frequencies, but it is technically very complex, and the handsets will undoubtedly be expensive.

The early versions of GSM in 1992 will provide a three-fold improvement in spectral efficiency over the current analog cellular system. But at a later date when better vocoders come along, it will be possible to drop the voice-coding rate from the current 13kbps to 8kbps and effectively double the channel availability.

Europe is clearly taking the lead in telecommunications recently, leaving both the USA and Japan behind — mainly because modern telecommunications depends on designing standards that everyone can live with. The Europeans with their multitude of states, hates and rivalries, have more need for compromise and compatibility than anyone else, and so more experience at getting these things right on the international scene. So assuming there is going to be a world standard, the wise money has been bet on GSM.

Enter CDMA

But almost overnight, the scene has changed once more — and quite dramatically. Although GSM is still the favourite, an old technology called CDMA (Code Division Multiple Access) has suddenly reappeared as a likely challenger.

CDMA wasn't even considered more than a faint possibility until last year. It is a modulation technique used by small-aperture satellite services and by the military, dating back to World War II, and it was widely held to have intrinsic problems that made it relatively useless for large-scale domestic terrestrial use.

But less than six months after the American Cellular Telephone Industry Association (CTIA) decided unanimously to introduce TDMA as the preferred standard, AT&T and the three largest of the seven US regional telephone companies (RBOCs) — Nynex, PacTel and AmeriTech — are suddenly having second thoughts.

A small San Diego company called Qualcomm has convinced them to sign agreements to develop CDMA cellular phones. And now after preliminary field testing, they are all enthusiastically promoting this technology as the way of the future. Although there are no working handsets yet in production (these will come this year) both Nynex and PacTel have said it is likely that they will introduce CDMA, even if the rest of America stays with TDMA. If necessary, they will offer a dual service.

Nynex, which takes its name from

New York and New England (Boston, etc) is probably the most enthusiastic proponent of CDMA, because it believes the technology offers a solution to the problem of spectrum over-crowding in New York city — a market that is already saturated and yet seemingly needing to grow by massive amounts each year. PacTel has a similar problem in Los Angeles, as has AmeriTech in Chicago and Detroit.

So with this testimonial, CDMA is obviously a technology worth examining — even if it is too early to make a decision. Qualcomm's CDMA system should be in use by the middle of 1991 in New York and Los Angeles, and this coincides with Australia's timetable has for introducing the second and third cellular networks.

Understanding CDMA

If you look the term 'CDMA' up in a computer/communications dictionary you'll probably not find it — or only a passing reference. In the latest textbooks you'll probably not fare much better — even if you try the generic terms 'Spread Spectrum' or SSMA (Spread Spectrum Multiple Access). In fact, if you go back through the technical literature you are forced to conclude that:

- Spread spectrum/CDMA techniques have been of very little interest except in military and satellite communications.
- CDMA's main value has been in its inherent security. Defence considerations have kept the literature to a minium.
- You need an advanced degree in higher mathematics to understand how it works, anyway.

The last is certainly the case! And since you won't find out much about these systems in magazines and textbooks, it is worth spending a minute trying to grasp broadly how 'code-division' multiple access differs from frequency-division and time-division — and the implications of the difference.

In frequency-division multiple access (FDMA) all users transmit at the same time, but they each have their own narrow band of frequencies. With time-division multiple access (TDMA), all users occupy the same bandwidth but transmit in a rotating time sequence — one after the other in a cycle, called a 'frame'.

The CDMA technique allows all users to share the full bandwidth available, and yet all can transmit at the same time — which on the surface doesn't make sense. The idea seems to conflict with basic concepts of how radio systems operate — everyone transmitting at once across the full bandwidth must surely create a jumble of noise.

Which is actually so. But in CDMA, each user's signal is separated from the total jumble by the identification of a unique code. It's a complex technique that I'm not mentally equipped to explain except by the most simple of analogies.

Think of a range (a bandwidth) of audio frequencies, such as that provided by a piano. With FDMA we could have a number of players each sending signals by each using one note (or a narrow band of notes). Some users will be only playing at the treble end of the piano, others in the middle range, and others at the bass end, but each will have a specific audio frequencies that they alone can use — and to avoid interference we would leave guard- bands (unused frequencies) between each adjacent player.

TDMA allows a number of users to share a range of frequencies, but they must take their turn in using the band. Each receiver knows that his signal is, say, in the third (or fourth, or fifth) time-slot in each sequence and so he can identify those meant for him, and extract those while ignoring the others.

With CDMA, the senders are all simultaneously playing notes — but they are playing chords, each of which consists of a number of notes spread across the keyboard. One player may be playing minor chords, another major chords and so on — but in each case the receiver knows which chord to expect, so he can reject any that don't match his expectations. If you listen to the whole bandwidth, it would be a raucous cacophony of noise, but by listening only for certain 'coded' notes (your chords), you can identify the signals of a single player.

On the surface, it appears that CDMA techniques are wasteful, because a multi-note chord needs to be played to transmit one bit of information. I.e., the signal rate must be much higher than the data rate — so the immediate reaction to the idea of code-division is to assume that this is a wasteful use of the bandwidth available. But it transpires that this is not the case and, in fact, in its practical application CDMA may prove to be very efficient.

Code-division is only one of the modulation techniques which uses *spectrum-spreading* techniques. Spread spectrum (SS) was originally devised for military use, to avoid jamming and detection and to allow the transmitter signals to be hidden behind the general level of transmitted noise.

Think of the piano analogy. If you were in a hall while these hundreds of chords were being played simultaneously, it would be hard to discover where in that mess of sounds, the signals were — unless you knew what to look for, and had a way of filtering the others out. Notice also, that it wouldn't matter if FDMA or TDMA users were using the piano bandwidth while others were using CDMA - you'd only occasionally get note conflicts, and these could be corrected by error checking schemes.

The earliest spread spectrum technique used was *frequency hopping*, where the sender would transmit one 'bit' of information (analog or digital) at one frequency, then hop immediately to another frequency for the second 'bit', then to another frequency for the third 'bit', etc. You could only listen in on this conversation if you knew in advance the sequence of frequency changes that would be taking place. If you only listened on a narrow band of frequencies, the SS signal would appear simply as transient noise.

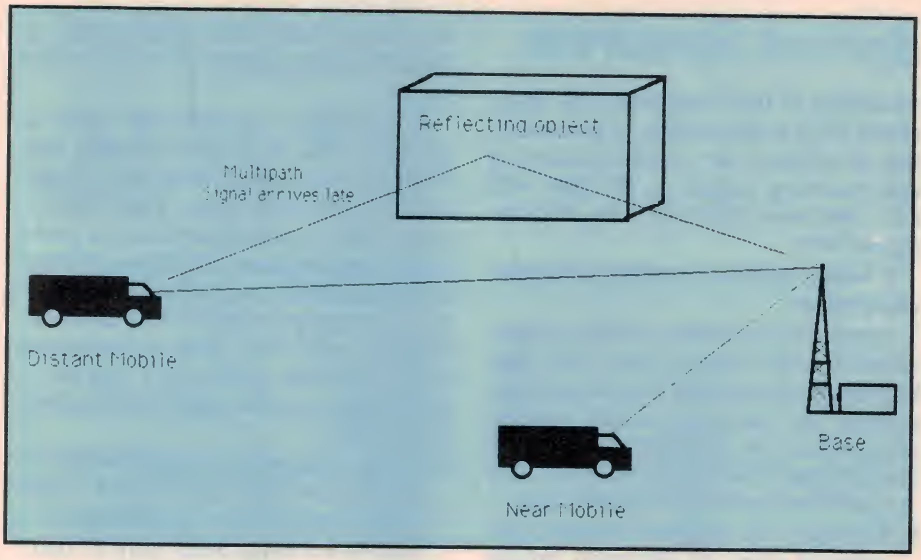
Similarly, even if a number of SS transmitters were frequency hopping within a certain bandwidth, they would only occasionally conflict with each other, and this interference would also appear as noise. As more senders used the bandwidth, the noise level would rise.

CDMA is the direct-sequence (DS) version of the hopping approach, where a binary code is used to simultaneously spread elements of the signal 'code' across different frequencies within the bandwidth.

The spread is decided by a special code (known to sender and receiver) and the changes are signalled by Binary Phase Shift Keying (BPSK). Forward error checking is provided and this allows correction of the data if bits are lost because of conflicts.

Since each transmitter is independent of the others, the combined effect if you listened with a scanner, is a bandwidth of seemingly random noise. But if you know which 'chords' to watch for, you can detect the correlation (or non-randomness) between the 'notes' in your 'chord' transmission, even if these are below the level of the random noise.

There are many different approaches to DS CDMA but, as it is applied to cellular radio systems, the base station (the receiver) first generates a long pseudo-random binary number (PN) which it transmits to the mobile (the sender), so that both parties share a



With TDMA near/far problems stem from the additional time taken to reach and return from a distant mobile. With CDMA, the problem is with the amplitude of the signals received at the base station.

single long binary code that is unique. There can be a very large number of these PN codes, so there's almost no chance that two mobiles will have the same one at the same time.

By using a synchronised shift register in the sender and the receiver, a constantly changing binary sequence can be selected from the PN number and used as a constantly changing identification code for the data transmitted.

In practice, the microphone output is processed then digitised through a vocoder. It is then modulated arithmetically with the current PN number sequence (the current PN sequence = 0, and the inverted PN sequence =1) and error checking is added. It is this combined code (now called for some inconceivable reason a 'chip') which is used to spread the spectrum across a 1.25MHz bandwidth.

The receiver is synchronised with the sender and it listens for coherent changes that represent the expected PN code sequence. By isolating this, it is able to correct any errors and extract the original digital signal.

Big benefits

My first reaction to this explanation was to assume that CDMA was an extremely complex and bandwidth-hungry way to go about implementing a radio link.

But I was wrong. Modern digital techniques have made these operations simple. Whereas in the years of World War II it would have required a room-full of electronics to do the coding and decoding, Qualcomm say that it now only takes four ASICs (Application Specific ICs), which can easily fit into a hand-held portable.

And the advantages seem likely to outweigh the technical problems. Here are the claims that are being made as to why CDMA is the cellular technology of the future. I think you will agree there's a lot that deserves further investigation here:

- **Bandwidth sharing**. Since a large number of users are sharing a single bandwidth, a CDMA cellular system doesn't need the complexity necessary (in both FDMA and TDMA) for finding available channels and allocating them to a new caller. All mobiles and base stations uses the one (total) bandwidth.

When a mobile moves from one cell to the next, TDMA and FDMA systems need complex 'hand-off' processes where the call is momentarily broken, then re-established from another base station. This is one of the problems with the current AMPS system when it is sending data (as distinct from voice). Bits are lost in the hand-off, and often call connections are lost if the new base station is already under peak load.

CDMA uses the same frequencies on all cells (even those that overlap each other) and so a 'soft-handoff' is possible. Two base stations can each be comparing the signal strength from a mobile and, at a certain stage, they simply decide between themselves which is preferable. So the hand-off can take place seamlessly, with no loss of bits; the mobile doesn't need to make a frequency change.

In FDMA and TDMA, each cell can only use a small part of the total available bandwidth (theoretically one-third, but in practice one-seventh) because adjacent cells would otherwise interfere with each other. CDMA doesn't have this problem because interference and noise are natural conditions.

FDMA and TDMA also have 'hard' limitations of another sort. There's a fixed number of channels available in each cell, and if one extra user tries to gain entry, his call will be blocked. But CDMA degrades 'gracefully' under load: each additional user simply increases the noise level, and so there is no hard-and-fast limit to the number of channels. In effect, CDMA is 'self- adaptive': when the overload condition get too great and the noise level becomes disruptive, some users will simply discontinue non-essential calls and wait for better conditions.

- **Multipath and timing problems**. The cells on a large-scale cellular system can extend up to 25kms from the base station, and since not all radio waves travel directly between the transmitting antenna and the receiver, some secondary reflected signals will always be arriving late. The further the mobile is away from the base station, the worse this *multipath delay* problem will be — and it is always unpredictable and therefore difficult to handle.

This is the classic multipath problem that creates ghosts on your TV set, but CDMA is particularly good at handling multipath delays because the receiver simply latches on to the most powerful signal, and treats the others as noise.

TDMA also suffers from another timing problem, when the mobiles sharing a single base station channel are at different distances from the station. Outgoing signals from the base are interleaved in the channel's frame-slots relatively easily and accurately but, because of the finite speed of radio waves, each mobile is not in exact synchronisation when it transmits. More distant mobiles are synced to a later-arriving signal, and the transmissions from these more distant mobiles will also take longer to reach the base station. Yet each incoming signal must be accurately interleaved with the others — each burst of data must accurately fit into one slot in each time-frame.

This propagation delay problem with GSM and DAMPS time-division systems is only solved by having special echo-back circuits in each mobile to measure the distance, and therefore calculate its synchronisation delay. The base regularly sends out a check- signal to each mobile, and this is immediately echoed back. The time taken for the

round-trip is then measured and transmitted back to the mobile, as an instruction to advance the synchronisation so that incoming signals to the base will then interleave perfectly into their assigned slots.

It works, but it's a complex and expensive process.

Without this provision, TDMA cellular systems would need to leave wide gaps between each time-slot to prevent signal overlap, and these gaps would substantially reduce the available data-rate (as guard-bands do in FDMA systems). This is a problem that CDMA doesn't have.

- **Security**. As Andrew Peacock discovered when he discussed private matters over his car phone, cellular systems have little inherent security. Calls on analog FDMA systems can be detected by a simple off-the-shelf scanner, and TDMA is not immune to the efforts of a dedicated eavesdropper with the right equipment.

Since CDMA was developed specifically for military security reasons, it is almost impossible for anyone to detect or decipher the transmissions without knowing the code that will be used. And since this is generated by a pseudo-random code generator with millions of possibilities, the system is about as secure as you can get.

Not only that, but since the signal amplitude is below the general noise level of the frequency band, it is almost impossible to track the source of the transmission without knowing the code as well. So both the location of the transmitter and the content of the messages are highly secure.

- **Variable bit-rate**. The audio from Qualcomm's handset microphone is fed to a variable bit-rate vocoder which has the ability to change sampling rates from 4.8 to 16kbps, depending on the demands of the speech.

With interactive speech, we only use each channel for about one third of the time — so in these pauses Qualcomm's vocoder switches down to the lower bit-rate. It could cut out completely, but that would produce a disturbing 'deadness' in the sound.

FDMA and TDMA systems hold their 'slots' open at the full data rate even when no sound is being transmitted, so they can't gain from these adaptive changes; but the CDMA world is statistical. The carrying capacity of the 1.25MHz bandwidth depends on the 'average' number of bits being transmitted, so lower bit-rates translate directly to more users.

Good 8kbps vocoders will soon be available, and it is quite possible that 4.8kbps voice with a dead pause is acceptable for many users. With CDMA, this is only a code reconstruction problem, so transmitters with these different data-rates could co-exist in the same system, with proportionally more users occupying each cell. There is no reason why different users can't opt for a price/quality service trade-off that meets their needs.

- **Integration with current systems**. It is possible that with CDMA, 1200 voice channels can be provided in a cell which today holds only 57 users (US figures). Spread spectrum can co-exist in a given bandwidth with other types of transmission, and Qualcomm are working on a 'dual-mode' handset design that is switchable between CDMA and analog FDMA. This would allow an easy transition to take place from one technology to the other.

Just as the complexity of the mobile units is simplified by the code-division approach, so is the base station. Only a single RF transmitter is needed in each rack of CDMA equipment, because the complex work is done at baseband for both send and receive.

- **Fading and power control**. You rarely get something for nothing in this world, and with spread-spectrum the major problem in the past has been in controlling the power of the mobile transmitters. This is called the 'Near/Far' problem, which is the result of nearby high-powered units swamping out the signal from more distant mobiles.

Qualcomm's major patents seem to be in techniques to fine-control the power output of their mobiles, so that signal levels from all mobiles are much the same when received at the base station. The technique they use appears similar to the way GSM solved its synchronisation delays, with regular control-signals exchanged between the base and the mobiles; but in this case they are modifying power levels, rather than transmission times.

By using this control, signal fading when a mobile passes behind a steel-framed building or a hill, doesn't appear to be a problem. But only time (and a thorough field test with production equipment) will tell. We'll know by about the middle of the year. ■

Amateur TV stars in historic test

Australia's amateur television operators were able to take part in an historic event late last year, when a co-operative effort by AUSSAT, the Gladesville Amateur Radio Club and the Wireless Institute of Australia provided the first ever national satellite broadcast of ATV signals.

by THOMAS E. KING, VK2ATJ

Amateur radio operators are a lucky lot. Not only can they be heard, but an increasing number can be seen as well, during test transmissions of high resolution, fast scan video. If this sounds somewhat like conventional commercial television broadcasts, you're right. However, there are more than a few significant differences.

Commercial television broadcasters are licensed to use high power levels in serving the public through educational and entertainment programming. In the process they attempt to make a profit, which in this economic climate is often a difficult task.

Amateur television (ATV) operators on the other hand are also licensed, but they are limited in power (to a maximum of 400W 'PEP', or peak effective power). They cannot broadcast music or any commercial programming, and most definitely are not allowed to earn revenue or accept payment in any form.

One major advantage that amateurs have over professionals is that they can build their own equipment and antennas, and set up their own studio. They can script, produce and even star in ATV transmissions.

Learning experience

Amateur TV, then, is a true hands-on learning experience — for enthusiasts wanting a new challenge from an already fascinating hobby, offering seemingly limitless opportunities for exploration and experimentation.

While some amateur TV activity can be seen in most capital cities and even a few larger provincial centres in Australia (signals are viewable by anyone with a good antenna and a conventional UHF TV receiver, tuned between channel 35 and 36 in a given coverage area). Sydney's Gladesville Amateur Radio Club has been a true pioneer in popularising fast scan, high resolution amateur TV in this country.

The North Shore suburban amateur radio club is not a newcomer to ATV, having first introduced regular test transmissions to Sudney ATV'ers in mid-1983.

Now, nearly 8 years later, the GARC conducts live weekly transmissions on Wednesday nights using its 20-watt ATV repeater on Channel 35+. (While new ATV repeaters are being placed in the 23cm and 70cm bands, there are still a number of established ATV repeaters located on the government-

Left: technicians from the ABC set up a microwave link in the shadow of the high-gain UHF antenna system normally used by the Gladesville Amateur Radio Club for ATV transmissions. The microwave link took the signals to the ABC TV tower at Gore Hill. Above: The professional looking test card which was transmitted before the live broadcast.

At the start of the historic ATV transmission, AUSSAT managing director and chief executive Graham Gosewinckel (left) was interviewed by Doug Mackie VK2XGX. Later a number of informative video tapes were transmitted.

authorised amateur television allocation between channels 35 and 36, at approximately 588MHz.)

The format for Gladesville's three hour Wednesday test transmissions consists of a prerecorded lecture on NAOCP or AOCP amateur radio theory, followed by short technical or scientific items from sources such as NASA, AUSSAT and educational colleges — as well as material from individual ATVers and ATV groups. The emphasis at all times is on education; the medium of instruction is amateur television.

Presenters for the live transmissions not only introduce each taped and studio item, but read news items from and about the Gladesville club, the Wireless Institute of Australia and the Australian National Teleprinter's Society.

The three hour long tape from the live test transmission is retransmitted on Fridays. On Saturday evenings a 2-1/2 hour test transmission is directed to those interested in computers and programming, with a series of pretaped lectures. On Sunday evenings the VK2WI broadcast is relayed, followed by a selection of technical and educational materials.

Test offer

The frequent Gladesville ATV tests, which can be seen over much of the sprawling North Shore of Sydney and to the southern and south-western suburbs and even to high points 40km west in the Blue Mountains were viewed by executives of AUSSAT, the company owning and operating Australia's national satellite system. The AUSSAT executives contacted Gladesville club officers to find out more about the club and its function.

After learning of the committment to using amateur television in its extensive educational activities (GARC is recognised as the foremost teaching body for amateurs in the country) AUSSAT executives offered Gladesville the use of a transponder on the national satellite system, to conduct ATV test transmissions over a greater area.

Further discussions took place and it was decided that the test — a joint operation between GARC and the New South Wales Division of the Wireless Institute of Australia — would take place on the evening of Wednesday, November 14, 1990. Shortly after this Australia-wide publicity began to flow to clubs, noting that amateur radio was claiming a world's first: the use of a transponder on a domestic commercial communications satellite to relay an amateur TV test transmission. (It appears that not even in the USA, with its nearly two dozen satellites, has such an event occurred!)

Notes to help amateurs receive the test were dispatched in time so that as many enthusiasts as possible could see a new signal from the sky.

Microwave link

A technical crew from the ABC arrived by mid-afternoon of November 14, and within an hour had established a temporary microwave link from Sydney's Lane Cove to the main ABC-TV tower at Gore Hill and on to the Film and Television Building at North Sydney TAFE. An existing microwave link between the TAFE and Belrose, northwest of the central business district, was activated. And from this suburban location, the site of AUSSAT's 'Capital City Earth Station', a 14.281GHz uplink *ku*-band signal was sent 36,000 km to the equator-orbiting AUSSAT 2, at 156° E. Instantaneously a 12-watt vertically polarised unencoded FM PAL signal on 12.533GHz from AUSSAT 2's transponder 5 was covering much of the continent on AUSSAT's southeast Australia footprint.

This blanketed a vast area, from Brisbane to Hobart and from Sydney to Adelaide. Also included was Canberra and Melbourne, and a number of

country regions in southeast Australia involved in ATV activities — such as Orange, Wagga and the Central Coast of NSW.

A spot beam was also directed towards Perth. But a sudden strike of Murphy's Law prevented most VK6 amateurs from viewing the signal via their ATV repeater.

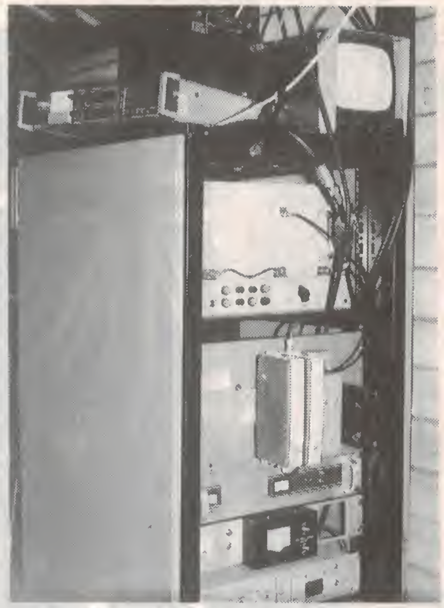
On the air

The first image that Australian enthusiasts officially saw at 7pm EDT was a colour bar/test card, highlighted with distinctive computer-generated graphics (Fig.1). At 7.30pm the colour test card was faded to black, to be replaced with a prepared introduction/identification video tape. A studio shot showing Doug Mackie VK2XGX, one of the evening's presenters, and Graham Gosewinckel, Managing Director and Chief Executive of AUSSAT, was the first live ATV scene replayed by a commercial satellite in Australia.

Following an introduction and subsequent interview, two pretaped technical segments from Ron Bertrand VK2DQ were aired, together with a series of five tapes produced by other ATV groups and designed to show interest in this special aspect of amateur radio. These came from the South-East Queensland ATV Group; the Central Coast Amateur Radio Club; operators using VK2RTS, the repeater of the Sydney Amateur Television Group; Melbourne's VK3RTV; and the South Australian ATV Group.

Interspersed between tapes was another of the evening's presenters: the WIA liason, Tim Mills VK2ZTM, reading WIA news items. There were also interviews with Roger Henley VK2ZIG, President of the NSW Division of the WIA; well known amateur devotee and promoter, Roger Harrison VK2ZTB; and a bulletin from the Australian National Amateur Radio Teleprinter Society.

At numerous intervals throughout the evening requests were made for signal reports, as facilities had been set up to take 'call backs' on 80m and 2m and by telephone. A total of 129 signal reports were received, either by radio on the night, by telephone and through the post. From VK1 came six reports, while VK2 had the most with 66. Just four amateurs from VK3 sent a report saying they watched the test; 15 reports came from VK4, 17 from VK5, and nine from VK7, while a sole VK6 amateur sent in a signal report.



The Gladesville Amateur Radio Club's UHF TV transmitter which puts out 20W at 588MHz. It normally feeds into a slot antenna system.

Ten non-amateurs who monitored the test also filed reports, including Clive Robertson, the dry humoured newsreader/compere of Sydney TCN Channel 9's *Robbo's World Tonight*. Portions of the test transmission were taped by the station and included as a news segment, to give the amateur TV event Australia-wide coverage through a commercial network.

At 10.38pm the historic AUSSAT test was over. The credits to recognise the many who were involved in the pioneering effort were read, and another page in Gladesville's diary of achievements was filled with a world-class success story.

Need more info?

The Gladesville Amateur Radio Club and the Wireless Institute of Australia are both keen to encourage people who may be interested in ATV but are unable to locate like minded individuals and organisations. Write with an SASE to the NSW Division of the WIA, Box 1066, Parramatta, NSW 2124 for the address of your nearest ATV group.

The Gladesville Amateur Radio Club videotapes all its electronics theory lectures given by Ron Bertrand, and makes them available on loan for a nominal fee to other radio clubs and individuals. For more details write with an SASE to GARC, PO Box 48, Parramatta, NSW 2111. ■

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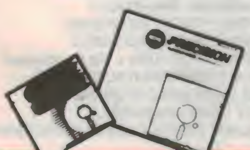

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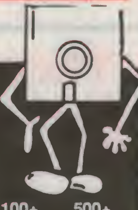

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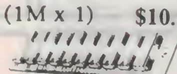

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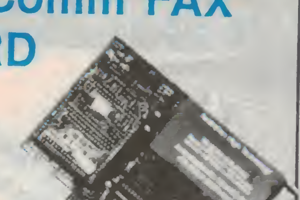

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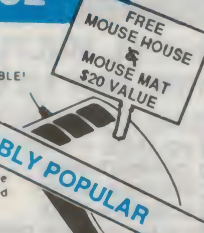

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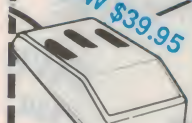

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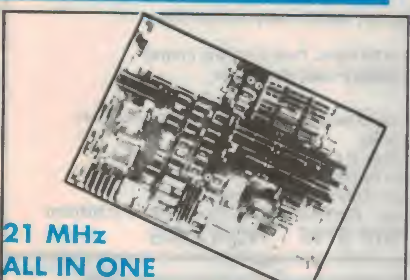

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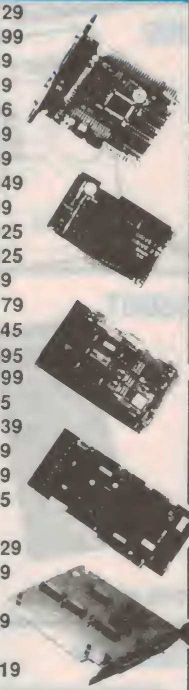

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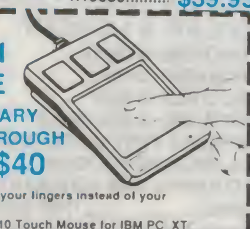

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- User's finger movements on the 58 X 48mm front panel of the touch mouse control the on- screen cursor movement.
- With no ball, the touch mouse requires no desk space for movement.
- No pad to get dirty and take up desk space.
- One finger can do all the users drawing.
- Compatible with all existing mouse software.
- RS- 232 serial port
- Especially suitable for laptops, the touch mouse saves on desk space.

FREE SOTWARE INCLUDED!

- MOUSE DRIVER
- TEST PROGRAM
- DEMO PROGRAM
- HIGH LEVEL LANGUAGE INTERFACE ROUTINE: Microsoft C, Microsoft Fortran, Quick Basic, Turbo C Pascal ...etc.
- POP-UP MENU

DR. HALO III GRAPHICS SOFTWARE

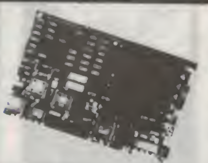
X19960.. $109

386-33 CACHE MOTHERBOARD

- Processor 80386-33
- Cache Controller 882385, 32 Bit Peripheral
- Memory 32KB Cache memory (35 ns)
- Expansion slots: 1 x 32 bit, 3 x 8 bit, 4 x 16 bit
- Intel* Combo Chip set: 82230, 82231
- Shadow RAM
- C&T 82C206 Intergrated peripherals Controller
- LED display for speed Indication
- Ability to run OS/2, MS/DOS, XENIX
- Real time clock/calender with battrey back up
- Baby AT* size board
- Reset button Connector
- Keylock button connector
- Speaker connector

X18112... $1995

386SX 16MHz MOTHERBOARD



- Processor: 80386SX-16MHz (0/1 wait state)
- Co-processor: 80387SX-16 (optional)
- CHIPS & TECH NEAT chipsets
- (SMT) Surface Mount Technology for chipsets & CPU
- Supports up to 2MB on board, (Sixteen 44256 and Eight 41256 sockets)
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- Memory Expansion Slot
- Optional 2-8MB memory card
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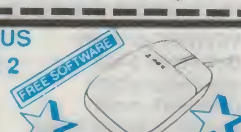
- Turbo Light and Hardware Reset connector
- Keyboard or Hardware Reset connector
- Power Good Signal on board • Baby size main board

X18094. OK RAM.................. $695

SUPER BUS MOUSE 2



The new Z-NIX Super mouse 2 allows you to get the most out of your computer and enhance your productivity. It gives you the ability to expand the versitility of your computer through the use of graghic software such as paint, draw and CAD programs. The super mouse 2 allows you to run programs like GEM and Windows which makes al operations of the computer easier and faster. Many popularSpreadsheets, databases, word processors and other programs can also be worked with the Super Mouse 2.

- 100% Microsoft Compatible
- IBM or APPLE Family Computer Compatible.
- Free Software with Pop-up Menus
- Life time Warranty

Also supplied with the Super Bus Mouse 2 are 2 FREE Telepaint disks which allows the user to perform high resolution graphics with the mouse.

X19951..$119

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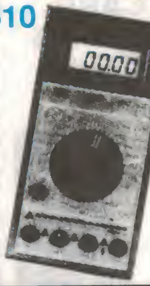

DC VOLTAGE: 0-1000V
DC CURRENT: 0-10A
AC VOLTAGE: 0-750V
AC CURRENT: 0-10A
RESISTANCE: 0-20M OHMS
CONTINUITY TEST, DIODE TEST
DATA HOLD
SAVE $20
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DIGITAL MULTI METER HC-5010EC
DISPLAY: 3 1/2 DIGIT
BASIC ACCURACY: 0.5% DC

DC VOLTAGE: 0-1000V
DC CURRENT: 0-10A
AC VOLTAGE: 0-750V
AC CURRENT: 0-10A
RESISTANCE: 0-20M OHMS
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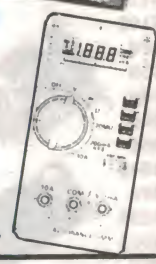
DIGITAL MULTI METER HC-889
DISPLAY: 3 1/2 DIGIT



DC VOLTAGE: 0-1000V
DC CURRENT: 0-10A
AC VOLTAGE: 0-750V
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DISPLAY:3/12 DIGIT
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DC CURRENT: 0-20A
AC VOLTAGE0-750V
AC CURRENT 0-20A
RESISTANCE: 0-20M OHMS
TEMPERATURE:-20C -1200C
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FREQUENCY, hfe TEST, DATA HOLD.
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HC-5050DB 3 1/2 DIGIT
BASIC ACCURACY: 0.5% DC

DC VOLTAGE: 0-1000V
DC CURRENT: 0-10A
AC VOLTAGE: 0-750V
AC CURRENT: 0-10A
RESISTANCE: 0-20M OHMS
DC AC RMS:-45dB -+50dB
TEMPERATURE: -20C-1200C
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USEFUL FOR TTL AND CMOS.
HIGH & LOW INDICATORS
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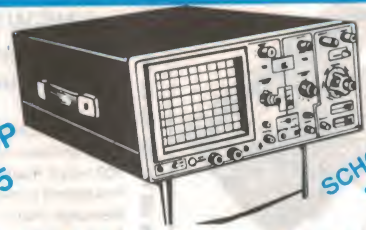
SCOOP $695



SCHOOLS TAKE NOTE $595 Tax exempt.

20 MHz DUAL TRACE OSCILLOSCOPE

CTR DISPLAY: - 150 mm rectangular
VERTIACAL DEFLECTION:
- Deflection Factor: 5mV to 20V / Div on 12 ranges in 1-2-5 step with fine control
- Bandwidth DC: DC to 20 MHz (-3dB) AC: 10Hz to 20 MHz (-3dB)
- Operating modes CH-A, CH-B, DUAL and ADD (ALT/CHOP L202 only)
- Chop Frequency: 200 KHz Approx.
- Channel separation: Better than 60dB at 1KHz

TIME BASE
- Type: Automatic & normal triggered in automatic mode, sweep is obtained without input signal
- Sweep Time: 0.2m Sec to 0.5 Sec/ Div on ranges in 1-2-5 step with fine control and X-Y.
- Magnifier: X5 at all times.

CRO Probe to suit $39.50 each - Cat. Q12201

TRIGGERING
- Sensitivity Int: 1 Div or more Ext: 1Vp-p or more.
- Source: INT, CH-B, LINE or EXT
- Triggering Level: Positive and Negetive, continuously variable level; Pull for Auto.
- Sync: AC, HF Rej, TV (each + or-) at TV Sync. TV-H (line) and (frame) sync are switched automatically by SWEEP TIME/Div switch.

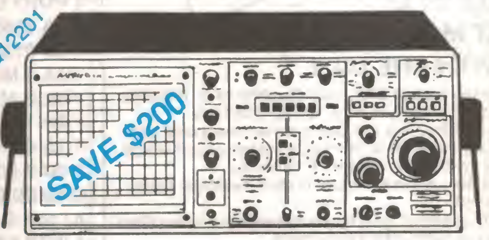
HORIZONTAL DEFLECTION
- Deflection factor: 5mV to 20V/ Div on 12 ranges in 1-2-5 step with fine control
- Frequency response: DC to MHz (-3dB)
- Max Input Voltage: 300V DC + AC Peak of 600V p-p
- X-Y operation: X-Y mode is selected by SWEEP TIME/ Div switch.
- Intensity Modulation Z Axis: TTL Level (3Vp-p-50V) + bright, - dark

OTHER SPECS: - Weight: 7Kg Approx - Dimensions: 162 (H) x 294(W) x 352(D)mm.

Q12105..........................RRP $750 NOW $695.

CRO Probe to suit $39.50 each - Cat. Q12201

SAVE $200



100 MHz 3 CHANNEL 8 TRACE MODEL 5510

This instrument meets the customers needs in quality of performance, efficiency, function, design, and cost! Being rugged, highly reliable and a multi-purpose 3-channel, 8 trace oscilloscope with a 6 inch domed mesh type 14kV post deflection acceleration cathode-ray tube and with a fine red internal graticule.

FEATURES:
- Compactness, lightweight, ruggedness and simple design.
- The diecast frame provides compactness lightweight and ruggedness .
- Easy Operation

Light torque lever switches and pushbutton switches are used.
- High Brightness CTR, high acceleration voltage and high beam efficiency of the 150mm rectangular CTR ensures a bright high speedsweep observation
- Multi mode display system

CH1, CH2, CH3, Add any combination or all the channels may be viewed simultaniously. Maximum 8 trace displaying is possible with the ALT sweep function.
- High sensitivity and wide frequency bandwidth.

The maximum vertical sensitivity is 1mV/DIV (when x 5 MAG)at 20 MHz or greater 3dB and mV/DIV at 100 MHz or greater -3dB.
- High input impendance

The input impendance of CH1, CH2, CH3, is 1MΩ ±2%, 25pF ±3pF

Q12109.........RRP $2995.00 NOW $2795.00

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	1-9	10-99	100+
P10516	$2.50	$2.25	$1.50

BNC CRIMP PLUG

	1-9	10-99	100+
P10530	$2.95	$2.75	$2.00

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TAKE 25% OFF THESE PRICES

- Six conductor shie[illegible] computer interfac[illegible]
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W126[illegible] [illegible].12

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W[illegible] · CIC16

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A10450..........$24.95

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Heatsink compound is applied to the base and mounting studs of transistors and diodes. It maintains a positive heatsink seal that improves heat transfer from the device to the heatsink, thus increasing overall efficiency.

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Designed to transmit at 40kHz (L 19990) and recieve at 40 kHz (L 19991)with up to 20V I/P on the transmitter. These units can't be heard so are ideal for TV remote control's , water level detectors, burglar alarms, motion detectors and information carriers as they can be either pulsed or used in a continuos wave mode.

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These terminals feature interlocking ends to form any number of conections. Standard 5mm spacing pins

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The perfect solution!
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P10560	14 pin	20¢	18¢	15¢
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P10567	18 pin.	30¢	25¢	22¢
P10568	20 pin.....	35¢	30¢	25¢
P10569	22 pin.....	35¢	30¢	26¢
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P10585	16 pin	1.95	1.80
P10587	18 pin	1.95	1.80
P10590	20 pin	2.95	2.75
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P10594	24 pin	3.95	3.50
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· DA15P 15 pin plug P12168	$3.50	$3.00	$2.50
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(With pins for easy board insertion)
Cat. C10170

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MICROPHONE SPECS:
Transmitting Frequency: 37.1MHz
Transmitting system: Crystal oscillation.
Microphone : Electret condenser
Power supply:9V battery
Range: 300 feet in open field
RECIEVER SPECS:
Receiver freq: 37.1MHz
Output level: 37mV(max)
Receiving sys: Super crystal oscillation
Power sup: 9V battery
Volume control: Tuning Led
Dimmensions:115x32x44mm
Weight: 220grams

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QUALITY 5MM LEDS

	1-9	10-99	100+
Z10150(R)	$0.15	$0.10	$0.10
Z10151(G)	$0.20	$0.15	$0.12
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Z10159	$1.10	$1.00

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David Packard steps in to rebuild H-P

Hewlett-Packard was one of Silicon Valley's founding firms, and a pioneer of corporate democracy, true open-plan office areas and 'management by walking around' (MBWA). However the company has grown enormously in the last 50-odd years, and as with many others this growth has created problems. One of H-P's founders has now come out of retirement, to help it rebuild and return to 'The H-P Way'.

by LEE GOMES

The company that David Packard helped build is struggling with a crisis of its balance sheet and its soul. In an attempt at redeeming it, Packard himself is back, managing — just like in the old days — by wandering around.

At atime of life when most industrial legends are content with a venerated emeritus status, the 78 year old Packard, chairman of Hewlett-Packard, is in his office most workdays. He also regularly travels to H-P sites nationwide, talking to many of the company's 92,000 employees.

Several years back, Packard had given up such hands-on guidance at the firm he co-founded 51 years ago. He was pulled back in recent months, though, by a challenge as big as any he had ever faced.

The value of the Palo Alto-based company's stock has fallen by half since early in 1989. There are doubts about the firm's high-stakes strategies in the computer business. There are also worries about its long-term profitability and concerns about some of its leadership.

And, in the development that associates say is most troubling to Packard, there are complaints, the company's growth and management style in recent years have caused the withering of the 'H-P Way,' a set of benevolent attitudes towards employees and customers that somehow set H-P apart from other firms, making it Silicon Valley's great class act.

A company once celebrated for being trusting and collegial has too often, some say, become suspicious and bureaucratic. A few years ago, H-P was the basis of an unflattering Stanford University business school case study of a company where employee experiences are often sharply at odds with lofty management rhetoric.

Those were among the factors that early last October led H-P, with Packard calling most of the shots, to announce a major reorganisation.

The shake-up eliminated some management layers in the computer business and gave special attention to the firm's non-computer lines, which contribute much of the company's profits but which some H-P-ers feel are 'bled' to subsidise the computer sectors.

The sales force was split apart, the post of chief executive office was given to two occupants and a number of managers were put in position to one day succeed veteran President, John Young, who is 58.

If it all sounds complex, it is. At a time when conventional wisdom maintains that companies are supposed to focus narrowly on their core business, Hewlett-Packard is a sprawling US$12 billion industrial empire with scores of divisions, each with its own distinct products and personalities. Collectively, they made US$187 million in profits on revenues of $3.2 billion in the most recent quarter.

H-P's roots, and most of its business, are in somewhat obscure technical areas, such as testing and measurement equipment.

In these fields, H-P is celebrated for dominating scores of disparate niches with high-quality, high-margin products that are built, as the H-P saying goes, 'by engineers for engineers.'

In recent years though, H-P has tried to expand out of these somewhat clubby, slow-growing markets by making a charge at the computer business. But it is having trouble adapting to computerdom's rough-and-tumble terrain, where profit margines are low and where copying someone else's crowd-pleasing design is often more important than your own finesse at engineering.

H-P's minicomputers exist in a stale market, its personal computer offerings have been largely yawned at and its efforts to expand in the high-prestige workstation market by purchasing Apollo Computer for $476 million in 1989 have bogged down. It has had some computer-related triumphs, though, in its

51 years after starting H-P, Bill and Dave's workshop garage in Palo Alto is now an historical landmark.

Dave Packard and Bill Hewlett take a 50 year look back at one of the first documents of company history — a ledger book listing cash payments from 1938-1941.

printer and engineering plotter line, most notably with the H-P laser printer.

Some say that product is a model for other H-P successes because it shows how the company, when everything goes right, deftly combines innovative engineering with strong marketing.

The firm's potential is such that Scott McNealy, head of industry-leading Sun Microsystems, reportedly once said the work-station competitor he most feared was H-P — but only if its many divisions started working together more closely. This then, is the company Packard is trying to renew. And its problems should not be overstated. H-P, even in troubled times, still has people and technologies — not to mention cash in the bank — that most of corporate America would envy.

John Young took the helm as H-P president in 1977 and was named Chief Executive Officer a year later.

While Packard routinely invokes Hewlett's name in discussing his current efforts, the 77 year-old Hewlett retired from management many years ago, and now no longer even holds an active board seat. Packard, however, remains at the very centre of power.

According to Forbes magazine, Packard is the 46th-richest American. Last year he owned 40 million shares of H-P, or 16.6% of the company.

But few people think Packard's remarkable return to H-P is motivated by concern about his personal finances.

Instead, most say it is because he wants to steer the company that is his life's work back to the values he believed in, when he started it as a young man.

"Bill (Hewlett) and I have not been very deeply involved in the company over the past few years. But recently we've recognised that some problems needed attention. So we've been working directly with John Young. The program we've worked out reflects the thinking of all three of us," Packard said in a rare interview recently.

He emphasised that "We're not doing this in any way to be critical of John. In the 12 years he's been CEO, the company has grown from US$1 billion to US$12 billion. Bill Hewletter and I think John has done an outstanding job. Now there are some problems that have developed. One of them has to do with the organisation of our computer activities. There has been a buildup of unnecessary bureaucracy. So we gave some attention to this. We've spent quite a bit of time working with John to design an organisation where he can devote his full time and attention to these important issues — with the organisation structure of the company and with getting a little bit of the 'H-P Way' back into the organisation. I might suggest an analogy to football. John Young is our quarterback and star player, and Bill Hewlett and I are going to be coaching him from the sidelines. We're not going to be calling the plays, but we are going to give him whatever help and coaching he needs."

Two things that H-P people who have left the company keep bringing up are that HP has become excessively bureaucratic lately, and that there seems to be less of the 'H-P Way,' especially on the side that deals with computers.

Who's responsible?

Packard agrees with these perceptions. "These problems were, in part, a reflection of the economy in the last decade. There's been a lot of concern about hostile takeovers, about financial wheeling and dealing instead of about basic management. And there's been attention to a structure called 'matrix management,' in which responsibility and authority is so diffused that nobody knows who the hell is responsible for what!"

"Now, unfortunately, some of our people have been carried away with some of those ideas, and we're going to get them back on track. I'm confident it's not going to be a very difficult problem. We have a tremendous amount of enthusiastic support throughout the company to do this. We have 90,000 people in the organisation. Bill and I feel a very solemn responsibility to those people. They joined the company, many of them, because of the H-P Way. We have a tremendous number of shareholders who became shareholders because they had confidence in our policies. We have a responsibility to make sure those things on which their faith was exhibited are satisifed with the continuation of those policies."

Packard doesn't believe anyone in particular is to blame for the problems. "I don't think it's any use talking about whose fault it is. It's probably Bill's and

Rebuilding H-P

my fault for not paying more attention to this before. The important thing is that we've identified these problems, and we're going to fix them."

First layoffs

Beyond the most recent organisation, Packard indicated that many more actions will have to be taken, including perhaps the first round of lay-off in the company's history.

"There's no question we're going to have to cut the workforce. And one of the reasons it's important for Bill Hewlett and me to be in on this is that we're probably going to have to make some painful reductions in some places. But those will be made only to the extent we are sure they will benefit the majority of our employees in the long run... I wouldn't want to make any projections on numbers at this time."

Apollo deal

H-P's computer business has taken a lot of money and certainly a lot of management mind share in the last 10 years, but the division's performance hasn't been overwhelming lately.

"It's mixed," Packard admits. "We have some very good things. Our peripherals business is strong, and Dick Hackborn (head of the operation that makes H-P's laser printer and a contender for the top H-P job) has done an outstanding job. The computer business is complex, and we haven't had quite the right reorganisation structure. This plan will enable John to give his attention to get those matters straightened out."

Some analysts have criticised H-P for its decision to take over Apollo after IBM had already investigated the firm and decided not to acquire it, despite its desperate need to quickly become a major player in the workstations market.

"So far, frankly, it hasn't turned out as well as we'd hoped. It's going to take us a little more time than we had anticipated. But we're going to take the steps necessary to make the Apollo people feel part of our team and take advantage of their technology. I'm sure that in the long run, we are going to look back and be glad we made that move. But I can't say it looks very good right now," said Packard.

Wall Street pressures

One of the reasons that has contributed to H-P's woes on Wall Street in recent years, is that the company has fallen victim to the same short-sightedness of most public companies.

"There's been too damn much concern in this whole industry about quarter-by-quarter profits. We're going to concentrate on those things which strengthen our company for the long run, and not pay as much attention to quarter-by-quarter profits as in the past. What this will do to the short-term price of stock, I don't know. But in the long run, it's going to get the stock price up where it should be," said Packard.

"We won't reduce research and development. We'll concentrate on those things that will add strength in the long term, which may not reflect favourably on short-term earnings."

Some analysts have suggested that H-P might split itself up into two or more independent companies or sell off some of the less desired product lines.

But Packard quickly put any such suggestions aside.

"I think the basic plan we're on is the right one for our company, and I don't see any likelikhood we'll make any changes in it. We're going to stick to our business and do our job right. I'm confident that in the long run it's the only way to win the ballgame." ■

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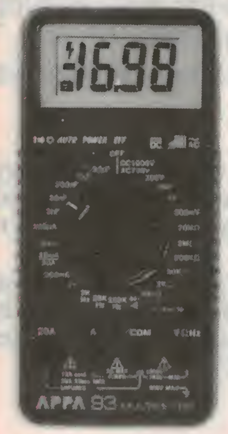

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Adc 200μA, 2mA, 20mA, 200mA, 2A, 20A
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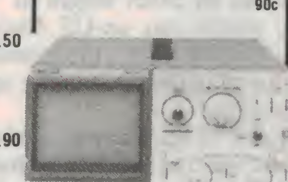

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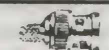

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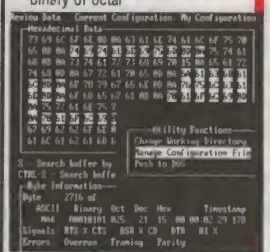

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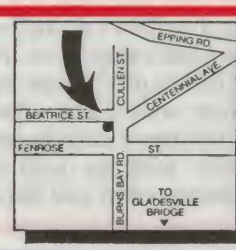

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Icom IC-R100 Competition:

The ‘runner up’ entries...

As promised, here are the ‘funny antenna story’ entries that we didn’t judge to be *quite* as funny as the ultimate winner, but were still enjoyable enough to make us want to share them with you. They may not have won their writers an Icom communications receiver, but at least they’ll attract a small publication fee! We hope you’ll enjoy reading them as much as we did.

Went with a bang!

During my earlier days as a military radio technician, I served with a field communications unit. One innovation noted in a US Army engineering report was the use of a tree as an improvised HF antenna. The idea was to allow ground forces to move rapidly and avoid the need to erect and dismantle conventional HF wire antennas.

It was decided to test the concept on a future exercise. We agreed on using a simple shunt feed into a tree trunk, since our HF antenna couplers would load almost any unknown impedance. Commencing with a power level of about 100 watts, we noted a change in loading over time and with frequency. The heating effect of the RF must have varied the tree’s impedance.

At the same time, a very smug and junior officer from another (rival) communications unit was watching curiously from a distance. He must have thought he was a whip (sorry!) on antenna theory as he approached our installation and began baffling us with mathematics. “...you’ll never receive clear signals using that arrangement...”, he added.

We increased power to about 1000 watts CW to check the loading, when the officer moved toward the tree to investigate any effects. When he was within a few feet of the tree, a gunshot-like sound rang out — which scared the daylights out of him! The RF power apparently created localised heating of the tree’s moisture, causing a pocket of steam to split the wood fibres.

We rolled in hysterics for quite a while and reckoned from the expression on the officer’s face and the way he was walking, the clearest signal we received was that he definitely needed a change of underwear!

(Philip Smith, Chapman ACT)

Wrong feeder

Around 1970, I was being trained as a technician by the BBC in Evesham, England. The training was very comprehensive and involved every facet of the television and radio industry, including short-wave transmission theory. One field day, I was drafted to Daventry, from where a part of the BBC’s World Service was transmitted.

The antennas were fed by open-line feeders, and to change the direction of the transmission, the feeders were lifted off one array and hooked onto another.

Safety procedures were clearly outlined in the work-practices manual, and so I duly banged the open-line feeders together before unhooking them.

Overkill?

The mast, which previously sported a large wind turbine, was now redundant. It was a beautifully designed, tilting type of some 25 metres high. It was the type of mast one always wanted for communications, but could never justify. It was just begging for a beam or two, and perhaps a heavy duty rotator.

The one catch was it was over 100 metres from the house and even with the best and most expensive ‘off the shelf coax’, there would be considerable signal loss.

Now it so happened I had an exact length of ‘super low loss’ 50-ohm coax, which was ex-US Navy and bought at a disposal sale. Unfortunately, the diameter of the cable was such that I was unable to acquire special ‘N’ connectors which would fit.

I guess I must have written at least a couple of dozen letters to suppliers without success until, with the help of an American friend, I tracked down a supplier in Los Angeles.

Sure he had them, but didn’t do mail order. This meant that I had to send a bank cheque to a ‘friend of a friend’ in the States, who had to drive some 200kms to pick up the connectors. There were quite a few further hassles, but eventually the last two available connectors arrived.

The following day with the help of Peter, another enthusiast, we commenced to pull the coax through the existing underground pipe — Peter one end, myself the other.

Now I know there aren’t supposed to be pythons in Tasmania, but I think the snake that slithered out was more python than tiger snake. By the time I found a 40-foot stick, the wretched creature had returned back into the pipe. Peter in the meantime had recovered from an hysterical outburst, grabbed his 12-bore shotgun and was standing at the ready.

Gingerly I continued to tug the ‘pull through’. Which end would ‘Monty’ come out? Fortunately, or unfortunately, it came out Peter’s end. With a sound reminiscent of World War 2, Peter discharged five rounds in rapid succession. It was sufficient to dispatch ‘Monty’ — and perhaps the entire local animal population.

At this stage it was getting quite late and I felt it wouldn’t be a bad idea to shout the bar. Returning from the house with an armful of tinnies, I noticed Peter had gone several shades of grey. Excusing himself as not feeling well, he hopped in his ute and took off home. I was halfway through my tinnie when I decided to inspect the remains of ‘Monty’.

It was now my turn to feel unwell. The reptile was in many pieces, but so was the end connector and coax!

Anyhow, it makes a damn fine flagstaff.

(Graeme Cuthbert, Wardlaws Point Tas.)

I stood in amazement as an arc of RF travelled across the open wires from the antenna to the transmitter building, followed by a loud bang as the PA stage exploded. I was changing the wrong feeder!

At the completion of my training, I was allocated to the Television Outside Broadcast Department...

(Nigel Williams, Annangrove NSW)

Can whales fly?

Humpback whales sing — not in the way that humans or birds do, but by putting together a variety of sounds, including moans, chirps, whistles and rumbles in a definite sequence, which may last for 10 minutes or so before being repeated. Recording and analysing the resulting 'song' is of great scientific interest and may help in establishing communication between animals and humans.

I was skipper of the research vessel the *Dick Smith Explorer* and, with a group of scientists from the Australian Museum, was operating out of the northern NSW port of Coffs Harbour on a project to record the songs of passing whales. When migrating humpbacks were sighted by our observers on a nearby hill, we would put out to sea and position the ship across their intended track. We would drop the sails, lower the waterproof microphones over the side and wait with tape recorder and headphones for the sound of their songs as they passed.

The scientist in charge was Bill, and one night he asked me if we could go out and listen for any whales passing during the hours of darkness. So we slipped out of Coffs and sailed gently along the coast, a mile or so out to sea. It was a beautiful black velvet night with a light breeze, so we reduced sail and moved calmly along at less than a knot with the microphone over the side, all quiet and enjoying the peaceful evening.

I was at the wheel and Bill was in the wheelhouse with me, headphones on, his sensitive tape recorder in circuit and the microphone on its lead, dangling over the side in many fathoms of Pacific Ocean.

Suddenly Bill broke the silence. "I think I'm going mad", he said. I didn't take much notice. Bill would sometimes make these wild statements. But he said it again. "I'm definitely going mad."

This sounded serious. "Not mad, Bill" I said. "Overworked perhaps, but not mad." He started to sob quietly to himself. "I can hear kookaburras!" he blurted out. I handed the wheel to Peter and started to look for the Scotch bottle.

"Here, old chap", I said, "let's have a quiet one and you tell me all about it."

Bill thrust the headphones at me. "Listen for yourself", he pleaded. "What do you hear?"

I sighed and put the phones on. But there, sure enough, were the kookaburras — all singing their silly heads off, loud and clear. What on earth!? Here we were, out at sea, just on midnight, microphone in the water listening for whales, and what do we hear, KOOKABURRAS!

There was silence in the phones, then a voice, well modulated and precise, said, "This is Radio Australia bringing you...", and so on.

I sighed with relief. By some mysterious means Bill's microphone lead was acting as an antenna and picking up *Radio Australia*. The signal was being rectified in the sensitive tape equipment and we happened to be listening when they played the station theme of laughing kookaburras.

I left the wheel to Peter, and Bill and I went off to find the Scotch.

(Donald F. Richards, Ebenezer NSW)

No problem!

A friend bought a farm a long way up a valley, and when I visited him, he wondered about TV reception from town, some 150km away. I designed and built a multi-element, single channel Yagi aerial, and stacked four together on top of each other.

When installed, the results were promising. There were a few small ghosts, but unfortunately one very large one, smack in the centre of the screen. Changing the location of the aerial did not improve it very much. I then suggested we try and find what it was causing the ghost.

A large scale map of the area was produced and measurements made of the distance of the ghost from the screen edges. Knowing this, and the speed of the electron beam, we worked out how far away from the house the reflection was. Then we drew on the map a circle of the radius of the calculation.

It turned out that the reflection was probably from the top of a large outcrop of granite rocks, 30-odd miles away, on another property. Well, I thought, that was the end of the matter. I had tried hard, but there was no way I could shift a mountain, could I?

Then my friend brought out the gelignite, and the neighbour gave permission. There was a very loud noise, and one ghost was exorcised!

(Peter Laughton, Albion Park NSW)

Magic rabbit ears

This story goes back many years to when I had my own business, and one of the most reliable TV sets we sold was the HMV 'Braddon' 43cm set. We were located about 160km from Melbourne, at a town called Dunolly and most of our clients needed a horizontal antenna for the Ballarat stations and a vertical antenna for the Bendigo stations. Some even had tall towers from the 1950/60 era to get the Melbourne stations.

Many clients therefore bought the portable sized sets for their better gain and thus saved the cost of two antenna and switch, as the inbuilt antenna pulled in the local channels on the better portables. We used to recommend the Braddon in those cases as it was a good performer.

At a Lions Club meeting one night I overheard a fellow Lion praising the set we sold him, and had him fined as an exaggerator for claiming his set got all the Melbourne stations as well as the locals on the 'rabbit ears' antenna. I knew the set was good, but not THAT good. He then had me fined for being a 'Doubting Thomas'.

To settle the matter several of us went to his house after the meeting and, sure enough, this set I had sold him proved me (and my radio theory) a liar. Admittedly Channel 0 was snowy, however 2, 7 and 9 (no 10 then, in 1976) were good and in colour.

I puzzled how this could be, and as a one time radio instructor felt compelled to solve the enigma. Early next morning back I went to investigate and in daylight soon spotted the culprit.

The next door neighbour still had his unused tower erected and the broken 300-ohm downlead was hanging over my client's house and re-radiating the signal gathered by the antenna on top of the tower. I proved this by terminating the ribbon into a 300 ohm load and no more Melbourne stations on the portable. Naturally my life was in danger until I

Icom 'runner up' entries

removed the dummy load and restored Melbourne stations to the owner.

Nowadays I don't say 'impossible' to unlikely tales, merely calling them interesting.

(Renny Williams, Mildura Vic.)

Bird problem

"Where's your 5/8 whip antenna?", I asked my Uncle George, a radio enthusiast.

"Well a couple of days ago," he said, "I was standing in the timber yard next door with a policeman, checking a suspected burglary, when we saw a flock of galahs fly in and land on my shed roof."

"One galah then flew on to the tip of the whip antenna, swung on it and flew off and on and off and on. When it got the whip swinging, two more galahs joined in with the first one and they all continued swinging together, flying off and on, etc., again making it really wave around."

"When another two birds joined the other three, the whip wobbled and bent over at a fair angle. Then the rest of the flock flew on and with their combined weight, bent the whip over until it broke. As it crashed to the ground, they all flew away screaming and screeching."

"All the time this was happening I yelled to the policeman 'Don't just stand there — get your gun out and shoot them!'. We both laughed as they flew away."

"Only God knows why they did it", mused Uncle George. "I almost think that some antenna company had trained the birds to go around and break as many antennas as possible."

(Lyndon Schultz, Salisbury Qld.)

'Antenna' — deceased

During the airline pilots' dispute, whilst en route to Darwin via bus, it was found necessary to stay overnight at a remote roadhouse in the Kimberley District, in north west WA.

There was little else to do but ingest copius quantities of 'singing syrup' in the bar with some of the locals, and it was there that I inadvertently let slip that I was by profession a marine radio officer, employed on an offshore drilling rig in the Timor Sea. Almost immediately an ancient, non operating, valve driven radio receiver was produced with the symptoms described as 'stuffed'.

After confirming this symptom, I decided to retire to my room for further investigation. On whipping the back off, I was confronted with what looked like a hairy decomposed body of some bush animal, which had somehow entered and subsequently expired.

On removing the 'deceased', it was clearly visible that the mains cartridge fuse had blown. Not having access to any spares, this was jumpered with a piece of fusewire. The set immediately came to life, and, with the addition of a piece of scrap wire to the antenna socket, numerous signals were received — to the delight of the owner.

On enquiring as to what the 'deceased' may have been, and how it had managed to enter the set, the owner advised that years before when he could get no signals, he discovered that by touching 'this' (the antenna socket), the set came alive.

Using bush logic, he reasoned that as a finger was a piece of meat-filled skin, a sausage would presumably produce the same results. So one was introduced — and I am assured worked perfectly for many months!

Quick fix

Most people take pride in their work. This is particularly true of professionals — engineers, technicians, right down to humble antenna installers of which skilled number I began my career. Later I graduated to that rare breed of TV technicians, who prefer to work on the basis of 'what it was last time', rather than assume the role of boffin in the field — time being the essence.

I found myself confronted with a TV that produced a picture like the reflections in a muddy puddle in George Street on a windy day. Only I wasn't in the city, but way out in the bush about 10 kilometres this side of the Black Stump. All the same the signal strength was good which I discerned, and demonstrated with my infallible and nonchalant charm, by substituting the antenna connection with my wet finger. Also the fault was no longer present, so we all went outside to look up at the antenna.

It was basically a three element Yagi, but half of the director was broken and lying back across the active dipole — reminiscent of the way a skinny aunt of mine used to cross her legs. It looked like a cheap job, which I remarked upon adding that I needed a ladder to get up there and remove the offending rod.

No ladder. I then remarked wistfully that I could pick it off with a twenty-two. My customer regretted that he didn't possess a '22' but, seemingly pleased at the prospect of an inexpensive and instant solution, offered me the use of his double barrelled twelve gauge, which he said was 'full choke' and wouldn't spread much at that range.

I suggested he do it himself, since he was used to the gun, but he declined on the grounds that he wasn't sure which part to aim at. The whole family gathered nearby to witness yours truly neatly incise the offending limb and I lined myself up for a clear shot.

I think I looked down the left barrel and honestly, only my target disintegrated, although the other half hung down which was immaterial. But unfortunately I pulled both triggers and the right hand charge took off both the junction box and the best part of the dipole.

I was saved by the kids. I thought they were trying to help me, but it seemed they were rolling all over me with laughter.

(Don Law, Tumblong NSW)

After advising him on the magic of antenna and earth connections, I had no further need of cash that evening in the bar...

(Bill Cowe, Glen Forrest WA)

Optical guidance

Way back in the early 1950's, before we had TV, amateurs had the VHF 1-metre band, at 288MHz. Yet another band taken away from us! All of the equipment was 'home brew', ex-disposals, as WW2 was only eight years behind us. Super-regen receivers and modulated-oscillator transmitters were the order of the day.

Antennas were the most varied, from 1/4-wave whips to multi-element Yagis. It was in this field that my mate, the late 5JG and I experimented most. From 'Js', colinear arrays with chicken wire reflectors, up to stacked Yagis.

Once you had a Yagi beam you had to have some idea where the other station was, to obtain maximum benefit from its characteristics. This is where John and I carried out

an amusing experiment. It was in November, and in those days fireworks were allowed — no one was worried about setting the dry grass on fire. We had a fair idea where to point the beams; it was 'over there'. My QTH was slightly elevated, and from my roof I could see the lights of John's suburb, about five miles away. One evening after it was dark we established contact on 288MHz, with '5 x 9' signals both ways.

Both of us had a couple of sky rockets left over from Guy Fawkes' night, and we decided that it was an ideal way to indicate each other's QTH. With receivers running, John lit the 'blue touch paper' and stood clear.

In the meantime I was sitting on my roof, complete with extended mic and PTT cable, gazing in the correct direction. Sure enough the sky rocket was seen to soar into the night sky, and burst into display. I wasted no time in informing John via 288MHz that I could see it. The procedure was reversed with John on his roof & I fired my Sky rocket, only to hear John's joyous reply, "I can see your rocket OK!"

From then on we both knew where to point our beams, although with '5 x 9' signals it was hardly necessary.

I believe that from all the practical experience gained in those days on one metre, we both passed our AOCP exams to become 'licensed amateurs'.

(Steve Mahony VK5AIM, Elizabeth Downs SA)

Slight misunderstanding

An Australian woman, having to spend several months working in India, settled into an apartment in a large Indian city. Lacking a television, she purchased a used set but found the internal antenna needed replacement. She summoned the caretaker of the building, an elderly Indian whose English was not so good, and began the torturous process of communicating with him.

"I need to get the evening service — I need an ANTENNA", she explained, holding out some money and indicating that he should make this purchase for her.

He looked quizzically from her face to the money and back to her face, obviously not comprehending. "Antenna Ahh?", he queried.

"Antenna Ahh!", he repeated in a sing-song tone, shaking his head from side to side.

"Yes. I want antenna quickly", she explained, thrusting the money into his hand.

A wry smile slowly crossed his face. His eyes shone with a mischievous sparkle. Comprehension at last.

"Madam pay after, if service is good", he smiled, gently pushing the money back, and left in a hurry.

Returning shortly after he informed her with a beaming face that 'Antenna won't be long", and added that "The service will be very good. Very special for her."

Not long after there was a knock on the door. On opening the door she found a handsome young Indian man with a most charming smile, dressed in tight fitting jeans and unbuttoned floral shirt.

"Anton at your service, madam" he announced, confidently removing his dark glasses.

"Anton?", she uttered in surprise. "I wanted a flaming antenna" she said, shutting the door in the face of India's answer to Tom Cruise.

(Odath Weerasinghe, Clayton North Vic.)

No light job

The lengths of steel angle iron were a bit awkward to maneuvre, and they clanged a bit as I positioned them for the legs of the new antenna tower that the boys were going to help me raise into position next weekend. The drill whined and screeched as it broke through for each new bolt hole, but the ear muffs helped protect my hearing for the faint voices I eagerly looked forward to tune into with the help of the new beam rotator.

By Wednesday I thought I'd easily have it finished for Saturday, fully assembled and wired, but I didn't reckon on the 'Boys in Blue'!

"Excuse me sir, what do you think you're doing?" The voice startled me. I guess the ear muffs prevented my normally acute sense of hearing from picking up his foot steps.

"I'm building a radio antenna tower, officer." (No need to upset him by not addressing him by his correct rank.)

"Do you realise what time it is, sir?"

I checked my watch. "Nearly 10:30", I replied. "What seems to be the problem?"

"Well sir, the neighbours were a bit concerned with all the noise and they couldn't see what was going on."

That's strange, I thought, I hadn't noticed any bushes between the back of their house and the tennis court where I'm working, when I've trod the well-worn path from their house to ours, over the years.

Then I grinned. Of course — new neighbours, and there's no moon.

"Sorry officer," I chuckled, "you don't need any lights when you're a blind ham radio operator!"

This is a true story, told to me by the late Ian Nichols, VK7ZZ.

(Bruce Champion, Mt Rumney, Tas.)

More next month...

That's about all of the runner-up entries we have room for this month. We'll publish the rest of them next month. ■

NEWS HIGHLIGHTS

MAJOR ADVANCE IN PHOTONIC SWITCHING

A polymeric integrated optics device, thought to be only the second of its type in the world, has been developed by a team from the Applied Sciences group at PA Consulting Group's Technology Division in the United Kingdom.

The device, known as a Mach Zender interferometer, has been designed and built for AKZO, the Dutch chemicals group and will enable the company to supply large bandwidth optical switches for use in optical communications systems.

The leaders of the development team, Dr Robin Godfrey, said PA was "working absolutely at the leading edge in this field. It is a technology of the future which will enable the full potential of fibre optic communications to be exploited."

"The interferometer serves to control the light signal of a communications laser diode and will enable information to be transmitted along fibre optic cables at a greater data rate than presently possible."

"As a chemical company, AKZO had the expertise to design the special material, known as a non-linear optical polymer, needed for use in these sorts of active devices, but they needed our help in producing the actual device," Dr Godfrey said.

The PA team called on sophisticated materials processing techniques perfected in the superconductor industry, first producing thin films of polymer of about a micrometre in thickness and then creating patterns similar to those of an integrated electronic circuit, but with optical connections. The device is now in an early prototype stage and could reach the market in two to three years.

BOSCH UPGRADES LOCAL MANUFACTURING

Robert Bosch Australia has established a $36 million electronics and fuel injection manufacturing plant in the Melbourne suburb of Clayton. The expanded and upgraded dual-purpose plant is producing fuel injection and electronic control systems for both automotive and non-automotive applications.

Bosch had previously imported fuel injectors from its parent company in Germany, and assembled the components (injectors, sensors and electronic control modules) to produce the systems used in many recent model Australian cars.

The upgraded facility gives the firm the capacity to produce the entire fuel-injection system in house — apart from the sensor devices, which are still sourced overseas.

Heart of the electronics plant is an in-line SMT system that is current placing surface-mounted components at the rate of more than 15 million per year. The new complex has also been designed for production in a 'clean room' environment, to enable quality control management of the high-technology equipment. Another feature of the plant is what is believed to be the only automated optical inspection system operating in Australia. The firm is also reviewing the use of a laser inspection system, which provides a more complete '3D' scan of the finished product for quality control purposes.

In addition to producing automotive systems, the plant also makes handset boards for cellular phones, and television switching gear for TV stations. At present it employs 130 staff, working in two shifts.

NEWS BRIEFS

- ***Philips Components*** has moved its Sydney office and warehouse from Artarmon to larger premises at North Ryde, now being located at the corner of Waterloo and Lane Cove Roads. The official address is 34 Waterloo Road, and the new phone number (02) 805 4455.
- A topical two-day conference on ISDN is being held this month in both Sydney and Melbourne by ***Technology Training Corporation,*** of Suite 403, 275 Alfred Street, North Sydney. Further details are available by phoning TTC on (02) 959 4229.
- Long established electronics firm ***AWA*** has announced its sale of subsidiary Dulmison — maker of electrical transmission and distribution equipment. The firm was sold by tender to 'a major international group', which paid $7 million but also accepted responsibility for Dulmison's liabilities of $19.4 million. Of this over $11 million had been borrowed from AWA.
- A 'revitalised' electronics show will be run in Perth this year, titled ***Switched on Living 91 — The Electronics Expo***. The show will be held at the Ascot Racecourse, from Friday September 13 to Monday September 16. The show has the endorsement of both the WA Consumer Electrical and Electronics Association and the WA Music Industry Association, and will have an expanded music component.
- Components distributor ***VSI Electronics*** has been appointed exclusive franchised Australian stocking distributor for General Semiconductor Industries (GSI), of Arizona. GSI makes Transzorb transient voltage suppresspr diodes, data line transient protectors and switching transistors.
- ***Optical Systems Design*** has moved to Unit 2, 5 Vuko Place, Warriewood 2102. The new phone number is (02) 913 8540, fax (02) 913 8735.
- Californian maker of SCSI-bus disk and tape host adaptors for computers CMD Technology has appointed ***Webster Computer Corporation*** as its Australian distributor. The firm's SCSI adaptors are made for DEC Unibus, Q-bus and BI-bus computers.
- ***Canon Australia*** has established a new joint venture company in New Zealand, called Canon New Zealand Ltd. The new company effectively rationalises affiliated firms Canon Business Machines (NZ) Ltd and Canon Optics New Zealand Ltd, and former CBM managing director Mr J. Enright is MD of the new company.
- Melbourne-based communications specialist ***Datacraft Computer Protocol*** has appointed Mr Bernd Rottinger, formerly of H-P Australia, as its new national customer support manager.

HI-TECH MOTOR IN SOLAR PLACE GETTER

Third place competitor in last year's Darwin to Adelaide world Solar Challenge, the University of Michigan *Sunrunner,* featured a high performance electrically commutated permanent magnet motor designed and built by American firm, MagnetTek.

The motor features high strength neodymium — iron — boron permanent magnets, low core loss lamination steel and a special finned aluminium shell for optimum cooling. Weighing in at 8kg, it is capable of producing two horsepower continuously and six horsepower peak — giving the car a top speed of 88 kilometres per hour.

The motor's electronic control system is a three-phase, pulse-width modulated inverter. Each phase consists of 16 power MOSFET transistors to efficiently handle up to 45 amps. The electronic control provides complete speed control and weighs only 4kg. Combined, the motor and control system provides a peak efficiency of 90%.

The U-M *Sunrunner* was powered by 14,057 aerospace quality razor-blade-sized silicon cells which covered an area of 140 square feet on the top and sides of the car. Operating at 16% efficiency, the solar array produced up to 1400 watts in full sunlight (about two horsepower, or the equivalent power of a portable hairdryer). This output drops to 600 watts in cloudy conditions or as low as 100 watts in rain.

AEDC OFFERS NEW COURSES

The Australian Electronics Development Centre has announced a larger and broader program of training courses for the first half of 1991, following its first full year of operation in 1990.

Two new 'How To' one-day courses are being offered this year, one titled 'Advanced Protel for Productivity' and the other 'Meeting AS 3901 Requirements'.

In addition four- and five-day Workshop courses are being offered in Electronic Product Development, Printed Board Assembly Technology, Total Quality Management and Designing for Surface Mount.

All programs are presented by industry experts and are devised to meet the purpose and criteria for eligibility of the Commonwealth Government's Training Guarantee Levy.

Courses normally run at the AEDC facility in Broadmeadows, Melbourne, but this year all of the courses are also being offered in NSW at a convenient Sydney location: the CIT Centre, in Crows Nest.

AEDC is a joint industry-government non-profit training organisation. Sponsor firms and organisations include Ericsson (principal sponsor), AWA, DIEP, DITAC, H-P, IBM, NEC, SEC, Siemens and Telecom Australia.

Further details on the courses are available from Matthew Wheeldon, AEDC marketing manager, by phoning (03) 302 1422.

NEW HONG KONG CENTRE FOR MOTOROLA

Motorola Semiconductor's new high-tech electronics design and manufacturing'Silicon Harbour Center' has been officially opened by the Chief Secretary of Hong Kong, Sir David Ford.

The highly automated 326,000 sq feet, three storey facility was developed by Motorola Semiconductors Hong Kong Ltd on the Taipo Industrial Estate, and has been built to service electronics manufacturers throughout the Asia Pacific region.

Silicon Harbour Center contains Motorola's Asia Pacific headquarters ana IC design and manufacturing centres for state of the art semiconductors such as ASIC, bipolar and MOS integrated circuits.

The multi-million dollar project is a calculated attempt to recreate the unprecedented success of California's Silicon Valley in the Asia Pacific region, according to the driving force behind the project, Mr C.D. Tam, Vice President and General Manager of Motorola's Asia-Pacific Division.

"Like Silicon Valley, the Silicon Harbour Center will be a place where creative minds flourish for the good of the community."

"For after all, when genius meets genius, the whole population shares in the higher energies awoken and radiated outwards"

"This unseen ripple created Silicon Valley, and it will do the same for Hong Kong if everyone plays their art," added Mr Tam.

Hong Kong was chosen as the site for the Silicon Harbour Center because of its abundance of technical talent, its excellent telecommunications lines with the rest of the region, and its strategic location as the gateway to China.

ELECTRONICS BUSINESS 'STRESS SALES' UP 60%

The electronic equipment industry has suffered a 60% increase in business stress sales over the last year according to a survey released by Ernst & Young, chartered accountants.

The computer industry was the major contributor to the electronic equipment category.

The overall incidence of stress sales of businesses across Australia in 1989/90 has risen by 66% over the 1988/9 period — and the outlook for the current financial year is worse.

This is revealed in a special survey conducted by Ernst & Young which added further grim confirmation of the high rate of insolvencies striking both individuals and businesses through-out Australia.

RAMTRON BUYS BACK FRAM LICENCES

Ramtron Holdings has announced the purchase by its US subsidiary, Ramtron International, of the Ferroelectric Random Access Memory 9FRAM0 technology manufacturing licences from Ramax Limited, which is owned by a division of the State Government of Victoria.

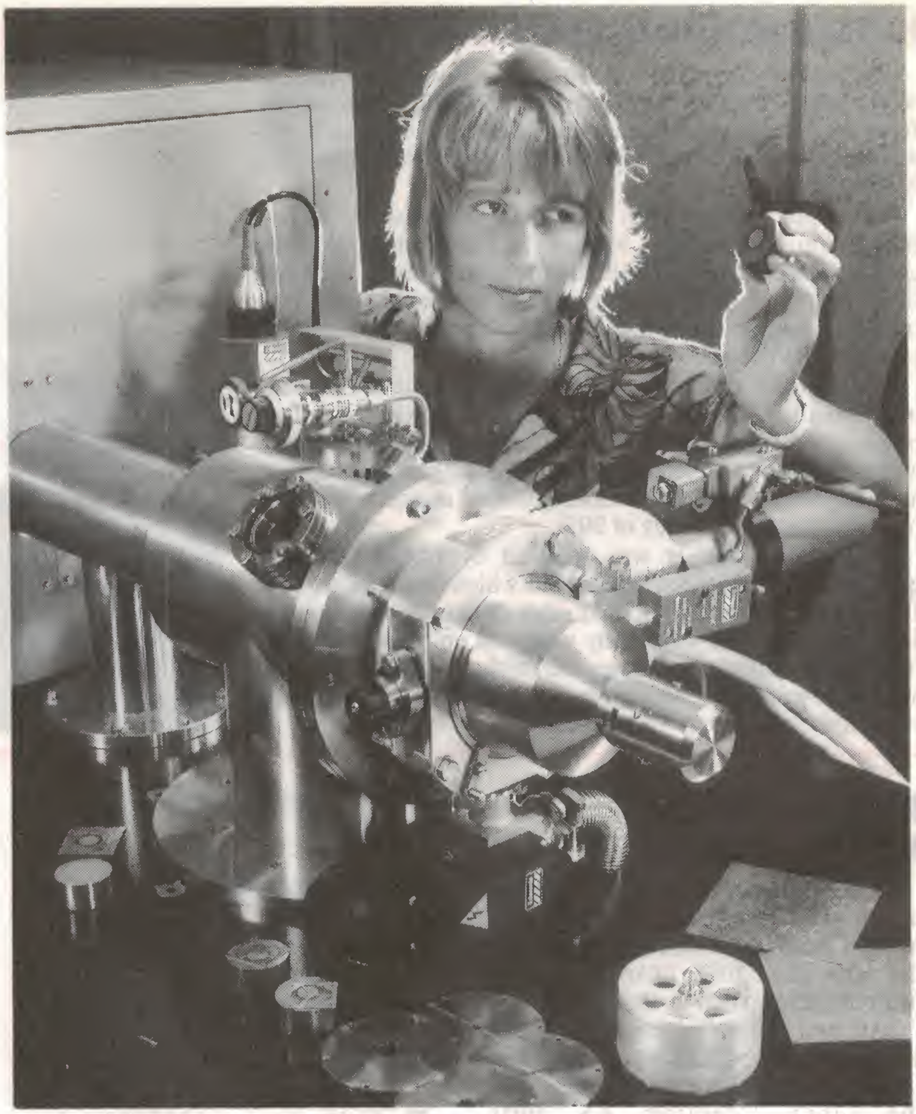
Ramtron was the successful bidder for the FRAM licensees, which were put to international tender by the Victorian Government.

An initial cash payment of A$935,000 was made, with a further A$12.5 million payable from profit sharing of future royalty payments and technology licence sales when made by Ramtron International Corporation, in areas relating to FRAM Gallium Arsenide applications.

Ramtron International said it acquired the FRAM manufacturing licences primarily to remove specific exclusivity provisions contained in these licences.

Ramtron is in the final stages of preparation for its FRAM product announcement. Production of the initial FRAM products is underway at ITT Semiconductor's plant in Germany, also at Seiko Epson's semiconductor operation in Japan and in Ramtron's own facility in Colorado Springs.

Successful production of the Ramtron-designed family of 4-megabit DRAMs has also commenced at NMB Semiconductor's DRAM fabrication facility in Japan, and customer samples of these 4Mb DRAMs were expected in the first quarter of this year.



VG Microtrace of Cheshire in Northern England, has developed the GloQuad, a quadropole-based 'glow discharge' plasma mass spectrometer which can be used to analyse the component elements in steel, general metals, precious metals and other materials. Glow discharge plasma mass spectrometry is one of the most powerful and versatile analytical techniques to emerge in the last decade.

MOTOROLA & APPLE LINK FOR HOME-BASED LEARNING EXPERIMENT

A novel computer-based learning experiment is bringing new knowledge and skills into the homes of factory workers and their families around Phoenix, Arizona. Known as Project SALSA — Southwest Advanced Learning System for Adults — the programme is a collaborative effort of education and business.

The project is being carefully watched by executives in business, government and academia, because it represents the first significant alliance between higher eduction and industry to apply satellite links and computers to adult education in the home on both a cost — and teaching — efficient basis.

Project SALSA employs sophisticated earth satellite and telecommunications technology to link personal computers in the home with a large library of interactive educational software, located at the University of Illinois.

Employees of Motorola, at its Mesa and Tempe, Arizona, semiconductor plants are participating in the six month pilot project using Macintosh SE computers provided by Apple Computer Inc.

The participants use the education software at these high-tech learning stations in their own homes, supplementing traditional classroom instruction.

Researchers at Rio Salado Community College, one of the Maricopa Community Colleges, are conducting a study

Hewlett-Packard's new HP85109B network analyser system extends semiconductor on-wafer broadband measurements of millimetre wave devices from 45MHz to 62.5GHz. The system provides greater than 63dB of dynamic range right to 62.5GHz and high power (minus 12dBm) at the probe tip to measure active devices requiring high test port power.

of the participants and a matched control group to see what effect the home-based learning envvironment has on the rate of improvement of the worker's reading skills, directly applicable to their jobs at Motorola.

In addition to Motorola, Apple and Rio Salado, project sponsors include the University of Illinois, which is providing free access to NovaNET, the U of I's satellite-based network for delivery of educational services; University Communications Inc., providing training in use of NovaNET and equipment for access to the network; Businessland Inc., providing surge protectors, special software and support services to the participants; and US West, providing private home phone lines for the computer link.

Motorola has also supplied, through its Universal Data Systems division, over one hundred 2400-baud modems that are being used on the private telephone lines to the homes of the participating Motorola employees. Motorola University has provided guidance and overall project coordination within the sponsor group.

Karen Mills, SALSA Project Director and Associate Dean of Instruction at Rio Salado Community College, said, "We are overwhelmed and more than grateful for the interest and participation of these businesses in this very exciting project. The implications are tremendous for not only improving the skills of the American workforce, but also potentially impacting the learning process throughout the families of the workers."

BOARD TO OVERSEE TELECOM/OTC MERGER

The Minister for Transport and Communications, Mr Kim Beazley, has announced the appointment of an interim Board of four Directors to oversee the merger of Telecom and OTC.

To give effect to the merger, the Government will incorporate a new wholly-owned company to which the existing assets and operations of OTC and Telecom may ultimately be transferred. The interim Board will be the initial Board of Directors of the new company.

The interim Board will be chaired by the current Chairman of OTC, Mr David Hoare, and the Deputy Chairman will be the current Chairman of Telecom, Mr Alex Morokoff.

Other members are Mr Bill Dix (currently Deputy Chairman of Telecom); and Mr Bill Mansifield (a current Telecom Board member and an Assistant Secretary of the ACTA)..

Mr. Beazley said that a further member of the interim Board would be appointed in the near future. He added that the primary role of the interim Board would be to prepare Telecom/OTC to face a competitive environment.

ALCATEL TCC WINS F-O CABLE CONTRACTS WORTH $500M

Australia's Alcatel TCC (Tasman Cable Company) has been awarded contracts worth approximately A$500 million to manufacture and supply the PacRimWest optical fibre submarine cable system, as well as a significant portion of PacRimEast. The remainder of PacRimEast will be produced by AT&T in the USA.

PacRimWest will link Austarlia to Guam, with connections to Japan and Asia. PacRimEast will run between New Zealand and Hawaii, connecting to North America and Europe. The high-speed digital systems will connect to TASMAN 2, the Australia/New Zeland link currently under manufacture by Alcatel TCC. Together, they will form the 16,500km, US$650 million South Pacific Network and provide the ability to transmit voice, data, text and video worldwide.

Tasman 2 will be operative by December 1991, PacRimEast by March 1993 and PacRimWest by December 1994.

The contracts were awarded to Alcatel TCC by OTC of Australia, TNI of New Zealand, KDD of Japan and AT&T of the USA. ■

FORUM

Conducted by Jim Rowe

Final words on fancy audio cables, at least for the present!

My aim this month is to try rounding off the second of our current pair of 'subjects that won't go away' — the one about fancy audio cables, and whether or not they're worth the extra cost. Obviously there's no shortage of interest in the subject, judging from the letters that keep arriving, but all the same I think it's time we moved on...

I won't be able to quote from all of the letters that have turned up on the subject of fancy cables since we discussed it last, in the October 1990 issue — there have been too many. Nor will I be able to quote most of them in their entirety, because they're often either too long or accompanied by a long reprint in support of the points made. But I'm hoping to be able to quote enough of each to give each correspondent a 'fair go', and provide a representative sampling of the remaining points of view.

To begin, then, here's an extract out of a letter from Mr Alan Jones, of City Beach in Western Australia:

It surprises me that the most obvious way to resolve the argument doesn't seem to have been considered. After all, if (as some contend), a few metres of ordinary copper wire can audibly mutilate audio signals, then logically a few kilometres would make matters a thousandfold worse. Or take it further: why not try a really long line — say 4000km — which must surely destroy music utterly?

Sounds absurd? But it's been done! For many years the PMG's Department relayed 5kHz-bandwidth ABC programs from Eastern capitals to Perth at audio frequencies, using open wires on poles. The conductors were single strand, hard-drawn copper of commercial purity, with thousands of compression joints. And their surfaces were thoroughly oxidised (billions of putative rectifiers to compound the skin effect!).

Yet the results were acceptable to radio listeners and ABC staff. And the measured harmonic distortion (just a few percent) could easily be attributed not to the wire, but to a dozen or more valve amplifiers in tandem, plus the many iron-cored transformers along the track.

I leave the conclusions to you. But I won't believe the advocates of 'super' cables are dinkum until they start winding their voice coils and crossover inductors with the same kind (and size) of wire!

Mr Jones has raised an interesting point, I think you'll agree. And even if one wished to discount his example of the East-West programme link, on the grounds that it belongs to an earlier era when technical standards were lower, I suspect there's another that is more current and equally valid.

When the ABC began its stereo-FM broadcasting only a few years ago, it was well known that all of the programme material originated in the Adelaide studios, and was then sent by Telecom landline to the transmitters in Melbourne, Sydney and (I think) Brisbane. I don't recall having seen any announcement that this arrangement has been changed, so presumably it may still be happening.

In any case, there was no noticeable degradation of the signals, which large numbers of FM listeners were quite happy to play through their stereo hifi systems. The general reaction was that the 15kHz-bandwidth signals were very similar in quality to those from a reasonably good magnetic pickup playing a good LP record.

I'm sure that the ABC engineers would not have used this landline system even initially, had they not been able to reduce the overall distortion to a very low level — even by today's standards. I'm also sure that the stereo-FM listeners would be a lot more critical in their listening than Perth's AM listeners might have been in an earlier era.

So although the Adelaide-Sydney link would only be about 1200km, somewhat shorter than Mr Jones' Perth link, I think it would still back up his point. I'd be very surprised if it used anything other than standard copper wire, with much the same collection of compression joints, etc. If the claims made by the 'fancy cable' enthusiasts were true, you'd expect that the effect of passing the programmes along a 1200km line would be quite dramatic, wouldn't you? Presumably the degradation would be around 600,000 times that in a typical two-metre speaker cable, and surely much too severe to allow the ABC engineers to achieve the performance they did — and still do.

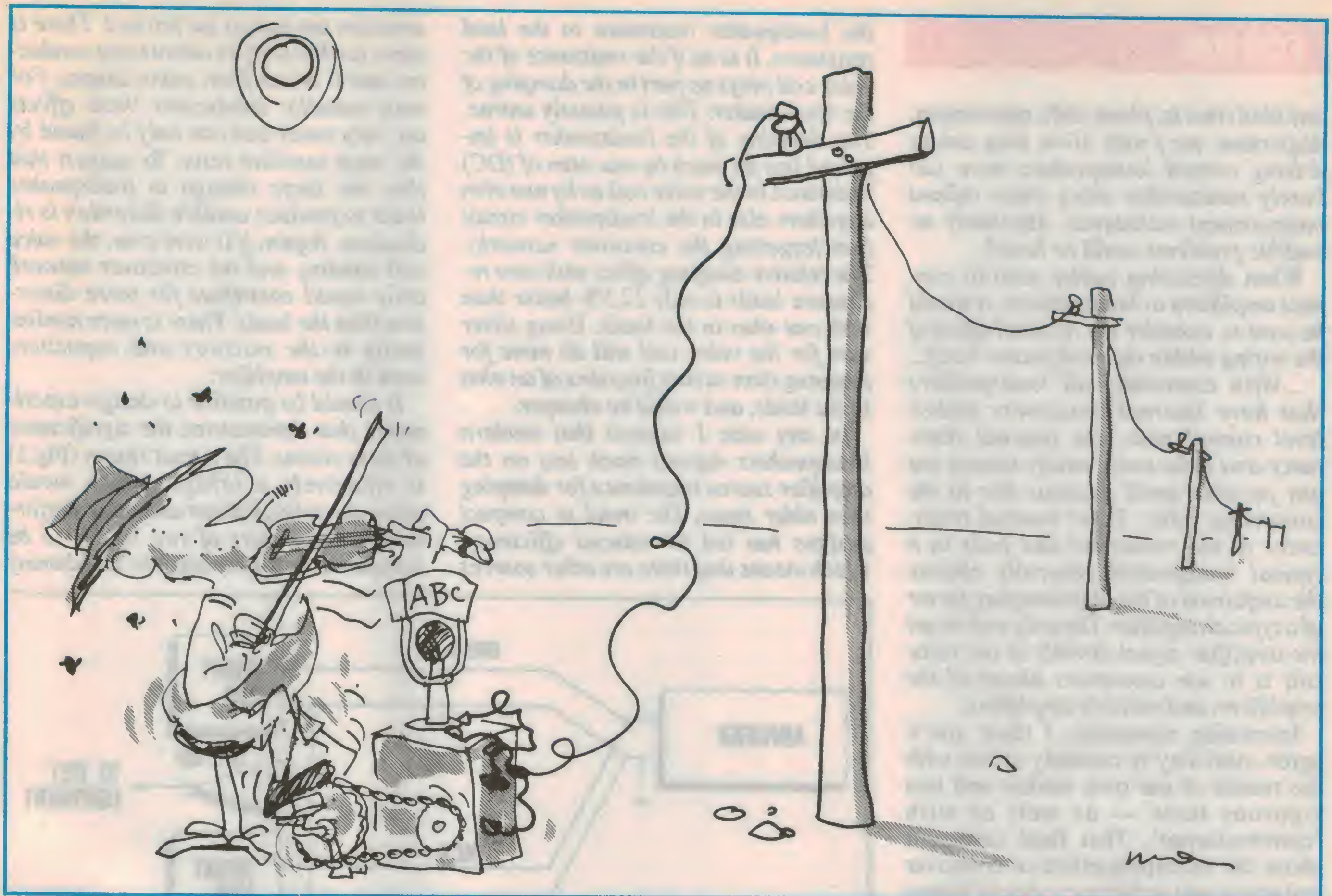
As I seem to recall a certain fictional French (sorry, *Belgian*) detective saying, "Eet gives one to theenk, no?"

I like Mr Jones' parting shot, too. Just imagine a tweeter voice-coil wound with Cardas Hex-link cable — or a crossover inductor (air-cored, of course) wound with the same stuff. The mind fairly boggles! I do remember seeing a reference to the use of OFC wire in crossover inductors and internal speaker wiring, and (I think) to tweeter voice coils wound in silver wire. But that's about all...

Anyway, thanks for your comments on the discussion, Mr Jones.

And now to the next contribution, which came from Geoff Nicholls, a former project development engineer with *ETI* magazine. Geoff sent in a copy of a paper published in the May 1980 issue of the *Journal of the Audio Engineering Society*, and written by Professor Richard Greiner of the University of Wisconsin. The paper is titled 'Amplifier- Loudspeaker Interfacing', and is essentially a report on a research study carried out to look at the behaviour of loudspeaker cables, crossover network elements and other items in the typical amplifier-speaker interface circuit.

Geoff Nicholls comments in his cover note that the paper raises some interest-



ing points, but that he doubts whether papers like that of Professor Greiner will cause anyone to change their opinion on the subject of fancy cables. This is, he says, "...since adherents of expensive cables seem to have an almost religious faith (and usually a complementary lack of basic electrical theory). Was it Lord Kelvin who said unless you can put numbers to an observation, you have achieved nothing?"

I won't try to quote at length from Professor Greiner's paper, because it's too long. However I'll try to summarise: the Professor and his colleagues looked at some nine different kinds of cables, of the type typically used for connecting amplifiers to speaker systems. There were three sizes of what the Americans call 'rip cord' (rather similar to our figure-8 plastic power flex, I gather), two sizes of similar and conventional 'speaker cable', a fancy 'braided' speaker cable, a special 'coaxial dual cylindrical' cable, conventional RG-9 heavy duty coaxial cable, and a heavy-duty 'welding' cable.

All of these cables were first carefully measured, to determine their electrical parameters. Then their performance was measured, using sensitive broadband difference amplifier techniques and with both resistive, capacitive and real loudspeaker loads.

Here are a few short quotes which give a reasonable idea of what they found:

When considering cables as transmission lines, thoughts come to mind of characteristic impedance, termination, matching, reflections and frequency dispersion. All of these are valid concepts, but they are not usually considered for very short transmission lines. And indeed, any reasonable-length loudspeaker cable is a very short line. The wavelength of a 20kHz signal is about 16km; thus a 10m cable is 1/1500 of a wavelength. Any fluctuations in the signal caused by reflections at the ends of this cable will take place at a frequency of 30MHz. or, to look at it another way, 1500 iterations toward the final voltage distribution in the cable will take place every cycle, at 20kHz. One must conclude that there are absolutely no audio frequency effects related to these reflections, for cables of any reasonable length.

Dispersion characteristics for selected cables are shown, for frequencies of 100Hz and 10kHz. From this it is apparent that for a 10m cable the delay differences are only a fraction of a microsecond, except for the braided construction which is a little worse. In any case the delay time, or frequency dispersion, is certainly not a problem for loudspeaker cables of any reasonable length.

The frequencies shown (for upper corner frequency and resonant frequency with a 4uF capacitive load) *represent the lowest possible values for about the worst possible loading one could consider driving. All of the frequencies are well above the audio spectrum.*

With most normal listening room situations, the cables will be short enough so that no audio frequency problems arise from the loudspeaker cables. It is interesting to note that changing to larger wire has little effect on the high-frequency resonance or falloff frequencies. Those frequencies are controlled by the series inductance. Thus there is some rationale for using cables that have low series inductance. Standard coaxial type construction of the cable seems to give all of the advantages of low series inductance without the serious disadvantages of high shunt capacitance.

...It seems unlikely that for runs of under 30m and with normal loudspeakers, there is any reason to use wire larger than 12 gauge for even the highest fidelity applications.

(In our tests) *...electrical problems of*

FORUM

any kind (that is, phase shift, attenuation, dispersion, etc.) with 10-m long cables driving normal loudspeakers were just barely measurable using these refined measurement techniques. Absolutely no audible problems could be heard.

When discussing cables used to connect amplifiers to loudspeakers, it would be wise to consider the residual effect of the wiring within the loudspeaker itself...

...With essentially all loudspeakers that have internal crossovers and/or level control pads, the internal resistance and inductance totally swamp out any possible small amounts due to the connecting cable. These internal resistances of the crossovers and pads in a typical loudspeaker generally obviate the usefulness of the high damping factor of a typical amplifier. The only way to get the amplifier signal directly to the voice coil is to use crossovers ahead of the amplifiers, and multiple amplifiers.

Interesting comments, I think you'll agree. And they're certainly in line with the results of our own modest and less rigorous tests — as well as with 'commonsense'. That final comment about the swamping effect of crossover resistance and inductance should please Alan Jones, too!

Thanks to Geoff Nicholls for sending in the copy of Professor Greiner's paper. He's no doubt right, though, that many of those in favour of fancy cables will still not change their minds, as a result of reading either this or any other objective testing.

And so to the next contribution, which came from Mr A.H. Freeman, a retired professional electronics engineer in Wollstonecraft, Sydney. Mr Freeman wrote at some length, so again it isn't really possible to quote him fully; but here are some representative extracts:

I have watched the seemingly never-ending debate on loudspeaker leads with growing amazement. I don't know whether I am more fed up with the gullibility of the people who buy the fancy wire, the dishonesty of those who promote it or the technical journals' timidity in debunking the whole nonsense.

I really think it is time to bring the whole subject down to earth. After all the basics have been known for nearly fifty years and most of the recent claims for OFHC copper, stranded wires etc. can be quantified and are amenable to experimental tests.

The question of damping has been given artificial importance by the use of damping factor defined as the ratio of the loudspeaker resistance to the lead resistance. It is as if the resistance of the voice coil plays no part in the damping of the loudspeaker. This is patently untrue. The damping of the loudspeaker is impaired just as much by one ohm of (DC) resistance in the voice coil as by one ohm anywhere else in the loudspeaker circuit (not forgetting the crossover network). The relative damping effect with zero resistance leads is only 12.5% better than with one ohm in the leads. Using silver wire for the voice coil will do more for damping than saving fractions of an ohm in the leads, and would be cheaper.

In any case I suspect that modern loudspeakers depend much less on the amplifier source impedance for damping than older types. The trend to compact designs has led to reduced efficiency, which means that there are other sources of damping — mostly acoustic — and that the ability of the driving source to affect the loudspeaker dynamics is less.

Stranded (Litz) wire has been promoted to reduce skin effect. the claim is that skin effect increases the resistance of a conductor at high frequencies and will effect the damping and frequency response. Quite true as far as it goes, but how big is the effect? For a conductor of 1mm diameter, skin effect increases the resistance by 1% at 10kHz. Who cares? Even for 2mm diameter wires, the skin effect is less than 10% at 10kHz. So, if one has leads this size, and each lead is 80 metres long, the lead resistance is 1 ohm at DC and 1.1 ohms at 10kHz. The high frequency response will be down by a whole 1/10th of a dB!

The improvement claimed for stranded wires, small as it is, will only be achieved if true Litz construction is used. Each strand must be insulated and the strands are woven, not twisted. Simple stranded wire is no better than solid conductors...

Claims made for single crystal construction are just as far fetched. There is some nonlinearity in almost any conductor and it arises from many causes. For most metallic conductors these effects are very small and can only be found by the most sensitive tests. To suggest that they are large enough in loudspeaker leads to produce audible distortion is ridiculous. Again, if it were true, the voice coil winding and the crossover network coils would contribute far more distortion than the leads. There is more nonlinearity in the resistors and capacitors used in the amplifier.

It should be possible to design experiments that demonstrate the significance of these claims. The circuit shown (Fig.1) *is effectively a bridge, which would allow the voltage drops and other performance parameters of two cables to be compared. It is necessary to use dummy loads in place of real loudspeakers, because it would be difficult to get two identical loudspeakers.*

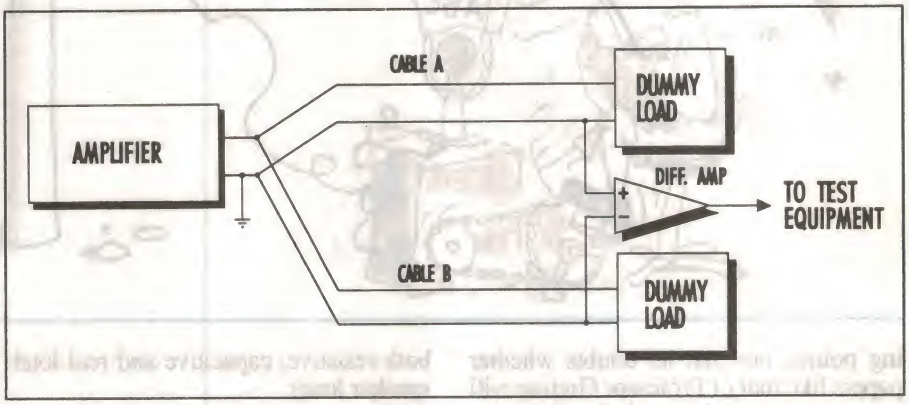


Fig.1: Mr R.H. Freeman's suggested circuit to allow comparison of the performance of two speaker cables. It's effectively a bridge, giving high sensitivity for accurate measurements.

One thing that audiophiles often lack is a sense of proportion. As a professional engineer, I learned the techniques of 'doing for ten bob what any damn fool could do for a pound'. One part of this was to recognise that the performance of a system was usually controlled by one item, and if this could not be fixed there was no point in doing too much about the other problems. The weak link in audio systems is still the loudspeaker, and improvements elsewhere need to be judged against its limitations. I note that in your August 1990 issue there was a review of a fairly pricey loudspeaker which had a distortion of 1.2% at 1kHz and 7% at 100Hz.

Thanks for your comments too, Mr Freeman. I'm not sure if you were lumping *EA* in with the technical journals that have been 'too timid to debunk the whole nonsense', but I hope not. We've certainly been doing our best to bring

some objectivity to the subject, and judging from the response I believe we can claim reasonable success.

Generally the points that Mr Freeman raises seem quite reasonable, as does his suggested method of comparing cables. In fact I suspect a similar technique was used by Professor Greiner and his colleagues, with the results described.

I like Mr Freeman's comment about the need to keep things in proportion, and his point that the loudspeaker itself is still by far the weakest link in the audio chain. This does suggest that we would achieve far more by spending effort on improving the drivers themselves, than by worrying about fancy cables — with the potential to provide a second-order improvement at best.

Tongue in cheek

The next contribution came from Noel Pierson, of Wagga Wagga in NSW. Mr Pierson wrote with his tongue firmly planted in his cheek, and was mainly commenting on George Cardas' letter which we reprinted in the September column. Here's enough of his letter to give the gist of his comments:

I am an avid reader of Forum, and enjoy the discussions you have. But September 1990's Forum was truly inspirational! I'm sorry, it wasn't your comments, but the letter of Mr Cardas.

Wow — I mean WOWWEE! I knew I was ignorant, but he made me feel like a true dummy. Not the store dressing type, or the one you spit a long way when you're a bit angry, but the real no-holds-barred nincompoop variety. I was glad when you said you were confused too...

Strands, strings, hmmm. Then it dawned — he was talking of the theory of super-strings. Yes, those n-dimensional wee-bitsy strings at the heart of a physical theory. Yes, it all fitted — the wire strings need to be in proportion of 5-8-13-21-34-54... — up to whatever dimension you could theorise upon. So I figured that he was talking at the sub-nuclear level.

Wow, being able to wind strands at this level must involve some pretty incredible technology! But I guess the CIA has been hiding this from us, all these years.

But the more I read on, the more dumb I felt. Even Scientific American didn't mention that super-strings (strands?) had resonance and phase skew problems. Oh well, just when I thought I had a pretty good stereo, I now find I am going to have to either figure out how to wind super-strings up into interconnecting leads, or shell out megadollars for some Cardas cable. That plus building a new home, with all the dimensions following the 5-8-13-... 'exponential' progression, with a 21-times time factor, and it could be pretty expensive!

Then I suppose I would need a bionic ear replacement, to be fully able to appreciate the 'difference' — maybe next century?

And you said you were only confused...

Hmmm... Here was I hoping that you readers would be able to explain what Mr Cardas' letter all meant, Mr Pierson, and you go and confuse me even more! Have you no pity on a poor magazine editor at all?

Seriously, though, I'm glad that no-one did write in to explain how Mr Cardas' letter made everything crystal clear. If they had, I'd have been most embarrassed. Presumably the lack of any response (apart from Mr Pierson's) meant that everyone found it just as confusing as I did.

To round off the subject, at least for the present, I'm proposing to quote from a letter and enclosure that turned up from Mr Doug Friend, of Annerley in Queensland. Mr Friend first makes the following comments:

I have found the controversy both amusing and frustrating — amusing be-

cause of the several jargon-touting hifi salesmen with whom I have disagreed at times, and frustrating because as in all areas of life, not even rational argument will convince people determined to believe otherwise. The hifi scene abounds with and capitalises on belief in not-well-understood physical principles and jargon.

The main reason for my writing is to share with you the accompanying article from the English magazine 'Home and Studio Recording', based on an interview with the well-known person Peter Baxandall. I draw your attention to the section headed 'Hifi Heresy', in relation to psycho-acoustics, etc.

My experience is that people in the technical side of recording usually understand the issues and avoid the hype. Perhaps your hifi readers would benefit from a short course in sound fundamentals.

The article enclosed with Mr Friend's letter is indeed very interesting, being from the May 1988 issue of *Home & Studio Recording* and written by Paul White. I'm sure many readers will be familiar with the name of Peter Baxandall, who is a highly respected British audio engineer and designer (among many other things) of the world-famous feedback tone control circuit that carries his name.

It's obviously not possible to quote at length from the article, which in any case would be covered by *H&SR* copyright. However I'd like to reproduce a couple of short sections from it, which are very much relevant to our present discussion. Hopefully *H&SR* and the author will allow this, on the grounds that it's a kind of 'review'. In any case, I'm happy to recommend that interested readers get hold of the original issue of the magazine at a library, and read the complete article.

Here are the relevant sections. First of all, author White asked Mr Baxandall if he believed there was any validity in the belief that valve and semiconductor amplifiers produced a different 'sound'. He apparently replied:

"I have never believed, even in the slightest degree, that valves produce audio that sounds in any way different from that produced by transistors or integrated circuits, providing you design everything properly. I feel the audio industry has gone very sadly astray in recent years with its belief in 'the valve sound', 'the transistor sound' and the virtues of oxygen free copper loudspeaker cables with lead tubes over the ends of them — and making sure you connect them the correct way round. Then there's the desirability of putting a flux dumper on top of your amplifier; I think it's utterly pathetic. I don't think it does our excellent subject any good at all in the eyes of intelligent people."

Mr White then asked him about the apparent concentration on speaker leads, when there are so many different metals elsewhere along the signal path — steel device pins, lead/tin soldered joints, copper PCB tracks, brass terminals and so on. Peter Baxandall's comment on this was:

"I'm afraid that my conviction in all this is that science is involved, but it is the science of psychology, not electronics. I think it is a fact that human beings, when placed in a situation with other people who claim they can hear a subtle difference, can easily convince themselves that they can too. They don't like to feel that their ears aren't as good as other peoples."

Paul White then goes on to relate an interesting little story of the power of psycho-acoustics, which Peter Baxandall was happy to tell against himself:

Peter then went on to describe a perfect example of this psychological effect, which came about when he was experimenting with a circuit incorporating a variable capacitor to make subtle changes to the high frequency response of an audio system. When the capacitor was turned clockwise, its capacitance increased and introduced a bit of high frequency cut. He adjusted the capacitor whilst critically listening to the output, and noted the slight change when the capacitor was turned clockwise, which seemed to bear out the theory of the circuit.

However on completion of the experiment, he noticed that he had forgotten to connect the lead of the variable capacitor — so it wasn't affecting the sound in the least. Because he was expecting an effect, he heard one, even though none was present. "If I can do this, anyone can", he added!

Paul White also gives the following quote from Mr Baxandall, specifically about fancy cables:

"...in the coils used for the delay lines in the Quad ESL63 electrostatic loudspeakers, there are several miles of perfectly ordinary, crude copper wire. The signals that reach the outer electrodes have been through all these many miles of ordinary wire, and if people say that signals that have gone through only two or three feet of pickup lead sound better if you use these special cables, for which you pay around £70 for a two or three foot length, wouldn't you expect signals that have gone through several miles of ordinary copper wire to sound pretty dreadful in the end? And yet everybody is saying that these new Quad electrostatic loudspeakers are absolutely magnificent sounding."

Did I just hear a faint cheer from Alan Jones, A.H. Freeman and all? Obviously they're in good company, with the famous Peter Baxandall firmly convinced that fancy cables are of benefit only to hifi sales people, rather than providing any real improvement in the actual quality of sound reproduction.

And that has clearly been the general conclusion, from both our own tests and the evidence and opinions contributed by readers. It's dangerous to be dogmatic, of course, but there really is no firm evidence that any of these expensive fancy cables provide any significant objective improvement over good quality 'ordinary' cables.

Until such evidence is produced, I for one will certainly continue using my existing ordinary cables.

And with those comments from all concerned, let's give the subject a rest for a while. I hope you'll join me next month, when we romp in pastures new. ■

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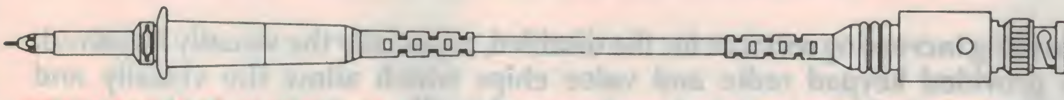

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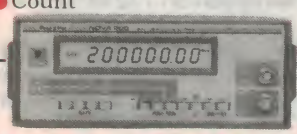

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SHORTWAVE LISTENING

by Arthur Cushen, MBE

The world opens for disabled listeners

Radio broadcasting is providing increasing services for the disabled, especially the visually impaired. Modern technology has provided keypad radio and voice chips which allow the visually and physically impaired to easily tune into the various broadcasts. This allows the impaired to retain their independence.

Radio listening is essential for the disabled, and there are several stations providing a special service, in particular reading services for the visually impaired. Many disabled listeners are tuning to radio broadcasts and this has often been their only means of news and information. This is rapidly expanding in Australia and New Zealand as radio reading services have been established for this purpose.

Radio for the Print Handicapped in Sydney, Melbourne, Brisbane, Canberra and Hobart have been in operation for several years and recently have moved from their out-of-band frequencies of 1620 or 1629kHz, and some stations have moved to the usual AM band. Their signals have been widely received throughout Australia and New Zealand, 3RPH Melbourne on 1179 kHz and 4RPH Brisbane on 1296kHz, both using 5000 watts and operating 24 hours a day. 3RPH has 11 hours of readings from local newspapers in its schedule. In Sydney, 2RPH on 1629kHz, which operates 24 hours a day, is expected to move to 1539kHz shortly, while 7RPH Hobart is scheduled to move to 1341kHz.

Radio is ideal

In New Zealand 2XA Levin, Print Disabled Radio, uses 1602kHz and is widely heard throughout the South Pacific on its new shortwave frequency of 3935kHz. It broadcasts on Sunday 0530-0800, and Monday, Wednesday and Thursday 0530-0900 UTC.

Disabled listeners find radio listening ideal, as it becomes the newspaper for the blind and a means of entertainment, information and enjoyment for those who are shut-in. With modern keypad receivers, even the physically disabled can now tune their radio receiver to the station of their choice.

Since 1980, when the keypad radio was introduced, it has meant a great deal of independence for disabled listeners who, especially if they are visually impaired, no longer have the problem of trying to read the analog dial, the frequencies and the pointer, and trying to tune in a particular station.

With memories built into the receiver, they can tune their favourite station with the touch of a button. The physically impaired will find that only a light touch of the button is required. Even in the wider field, voice chips can now allow the frequency to which the listener is tuned, to be spoken out loud.

Radio stations are also helping the disabled listener with their schedules, and in the case of blind listeners, Radio Canada International makes their 6 monthly schedules available on cassette, free of charge. Various radio clubs are also helping their disabled members by providing recordings of their bulletins on tape. Two of the leaders in this field are the Ontario DX Association of Toronto, Canada, and the National Radio Club of Poquonock, Connecticut, U.S.A.

AROUND THE WORLD

BRAZIL: Radio Braz, Brazilia, on 15265kHz was heard closing at 1920 UTC after broadcasting in English to Europe. They indicate that they are using 11745kHz to North America and request reception reports to Box 040340, Brazilia, Federal District, Brazil.

ECUADOR: HCJB Quito DX Partyline, which is broadcast on Saturdays to the South Pacific, has been extended to 45 minutes. The new compere is Richard McVicar and the session is heard from 0735-0820 on 9745 and 11925kHz.

FRANCE: Radio France International has dropped its English broadcast to North America which we used to hear at 0315 and now has three sessions 1230-1300, 1400-1500 and 1600-1700. The earlier transmission is heard on 21635kHz.

GERMANY: Deutsche Welle now use the studios and transmitters of the former Radio Berlin International, and the staff of the old RBI of over 2000 have been dismissed. The Berlin Studios are used only for 5 language programs and all other transmissions originate from Cologne. The transmission in English to Australia 0900-0950 is on 21465 and 21540kHz which are former RBI transmitters. The transmissions originating from Deutsche Welle at that time are on 6160, 11740, 17780, 17820, 21650 and 21680kHz.

SWEDEN: Sweden Calling DXers, which was established by Arne Skoog in 1948 and broadcast each Tuesday on Radio Sweden, has been reduced to a release on the first and third Tuesday of each month. The transmission to Australia is 1230-1300 on 11715, 17740 and 21570kHz. A repeat to North America on Wednesday 0330-0400 is on 9695 and 11705kHz.

USSR: Radio Tashkent broadcasts in two daily transmissions in English 1200-1230 and 1330-1400 on 7325, 9600, 9715, 11860 and 15470kHz. Reception on 7325kHz is the better signal here in the South Pacific area.

VATICAN: Radio Vatican Four Voices program is heard 0700- 0800 with English 0730-0745. The other transmissions are in Italian to 0715, French to 0730 and Spanish to 0800. The new frequency in use is 15210kHz, while the program is also available on 9645 and 11740kHz.

YUGOSLAVIA: Belgrade has introduced a new interval signal used to open and close their transmission. The English broadcast 1300-1330 is on 17725, 21635 and 21715kHz. Reception on the first two frequencies is good, but there is severe interference on 21715kHz. Radio Yugoslavia is also operating in English 0100-0130 on 9620 and 11735kHz. Other transmissions are 1930-2000 on 6165, 7165,15165, 17840kHz, and from 2200-2245 on 5955, 6100 and 15165kHz..

Radio for Peace International

Broadcasting from Costa Rica, Radio for Peace International is located at the University in Santa Ana and has been operating for the past 3 years. The station has increased its transmitters from one to three, and a new transmitting building is now under construction. New antennas are being erected and higher power lines are being fed into the area.

Most of the programs in the past have been transcribed, mainly from peace groups in the United States, but an expansion of local programs is expected shortly. Radio Peace International is a project of the University of Oregon, Eugene and the UN affiliated University of Peace in Costa Rica. The address is Box 88, Santa Ana, Costa Rica, and reports could be sent to the Station Manager, Mr. Graham Laytham. The latest schedule is Monday-Friday 2000-0300 on 13630 and 21567kHz; 2330-0300, 0315-0645 on 7375kHz; weekends 1800-0030 on 13630 and 21567kHz; and 0045-1345 on 7375kHz.

Voice of hope expands

The Voice of Hope has transmitters in Lebanon and near Los Angeles and is expanding into the Pacific with transmitters to be located on Guam. Their main transmission will be directed to China. While the transmitter is on site in Guam, the station is still negotiating with the Government for a suitable piece of land. The transmitter is 100kW and will use a curtain antenna. Though the station KHBN is not yet operating, it has been used on a test basis, having leased time from KSDA of Adventist World Radio to carry initial broadcasts. High Adventure Ministry, the operator of KSBN, plan to link by satellite the transmitters in Lebanon and Guam with the key station in Los Angeles. This means that simultaneous broadcasting, which should cover two thirds of the world's population, will be possible from these sites. ■

Ring the Vatican Radio if you wish to hear a recorded message from the Pope.

This column is contributed by Arthur Cushen, 212 Earn St, Invercargill, New Zealand, who would be pleased to supply additional information on medium and shortwave listening. All times are quoted in UTC (GMT), which is 10 hours behind Australian Eastern Standard Time.

When I Think Back...

by Neville Williams

'Shadders on the wall' — 2: the country picture show goes 'talkie'

If last month's story about an old-time country picture show emphasised the primitive side of such an enterprise, this month's sequel is similar. The difference is that it was enacted about 10 years later, when the same show had to be re-equipped for the 'talkies'.

As I indicated last month, my grandfather A.P. ('Alf') Hicks 'pulled the plug' on the original show around 1930, when interest in silent features and their ready availability diminished sharply with the introduction of sound films. Besides that, the novelty of running his own picture show had long since waned, and the prospect of spending Saturday evenings by the family fireside was more inviting than the hassle and expense of installing the new projection equipment that would be needed.

How practical it would have been at the time, also had to be considered. The projectors would have to be driven at a higher and constant speed, free from 'wow' — which ruled out the existing 80V DC drive motors and slipping belts. In the continued absence of AC mains, that could have meant installing a custom- built DC/AC rotary converter and running it from a well regulated supply, unaffected by the projection arcs.

The amplifier system would also need a 240V AC supply, or else be custom built to operate from 80V DC.

By comparison, a crackling log fire in the living room grate looked just too inviting and he accordingly threw an oil-stained dust cover over the existing projectors, locked the projection room door and settled back to ponder his pending retirement.

About that time, the proprietor of the theatre in nearby Picton invited him to drive down one evening and have a look at the sound equipment he had installed some time previously. Much to my delight, I was invited to go with him and, as well, see my first-ever talkie — featuring, as I remember, Janet Gaynor.

Still attending high school, my knowledge of electronics at the time was limited to the superficialities of a crystal set and what I had picked up from my father's strictly hobby interest in 1920s-style battery sets. I knew enough, however, to feel cheated when I realised that the sound system in the Picton theatre was sound-on-disc rather than the 'real thing': sound on film.

Sound on disc

These days, I have only the vaguest recollection of seeing two otherwise conventional projectors with a bulky structure bolted to their blind side supporting an enormous (16", or 40cm in diameter) turntable and pickup. The operator explained how he had to load the film with a particular frame in the gate and place the pickup at a given spot in a particular track. Sharing a common drive, both would start together and would remain synchronised — provided no break occurred in the film and no- one bumped the turntable.

Much more recently, I had a most enlightening conversation with a friend, who was related to the former operator of a similar sound on disc show in a small town in the NSW Blue Mountains. As his unofficial assistant, he saw some of its problems at first hand.

Sound films did break on occasions, he said, for precisely the same reasons as did silent films. Everyone just had to be that much more careful with them to keep out of quite horrible trouble.

If the film broke after the first sprocket the operator could switch off the drive without losing sync. Then, without touching the pickup, he could carefully nudge the whole thing forward sufficient to re-thread the loose end of the film and start again. If, on the other hand, the break occurred ahead of the first sprocket, the operator could only 'guesstimate' how much film to pull through to match the position of the pickup on the disc. If he got it wrong, he had to make a decision whether to put up with the error or try nudging the pickup this way or that, a groove at a time.

Said my informant: "Some operators were more adept at this than others. The remainder were just lucky or unlucky on the night!"

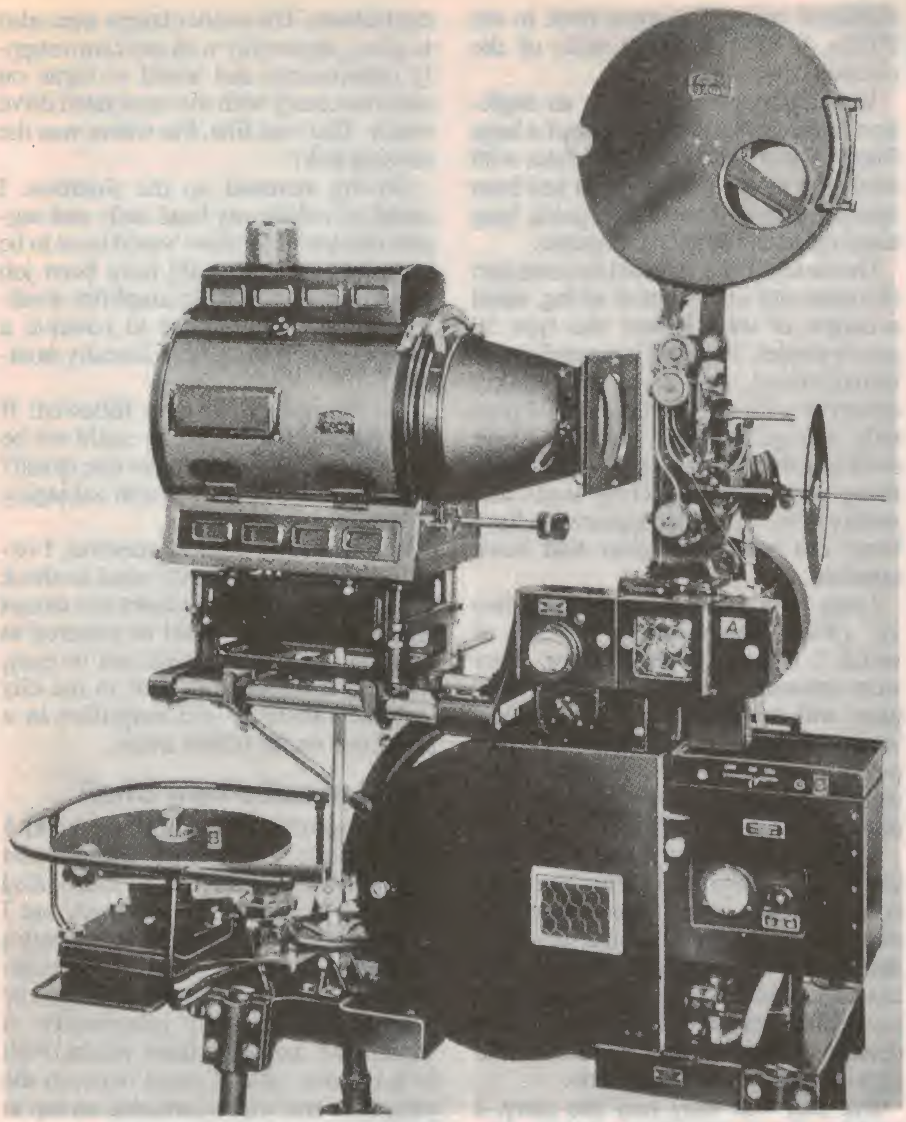
In repairing a damaged film, it was important not just to snip out the affected frames and join the remaining ends, because that could shorten the film enough to prejudice synchronisation after the splice. The appropriate procedure in the field was to replace any damaged frames with an equivalent length of opaque film.

But the problems didn't end there. According to my friend, the hall in the Blue Mountains town, where his relative acted as operator, was on the same subterranean rock shelf as a segment of the main western railway line which passed close by. When a huge 57 type goods loco chugged past, the whole hall would vibrate. So also did the pickup arm — which, on occasions, would jump a track, again posing the operator the question whether to accept the situation or 'have a go' at correcting it.

Back at Bargo

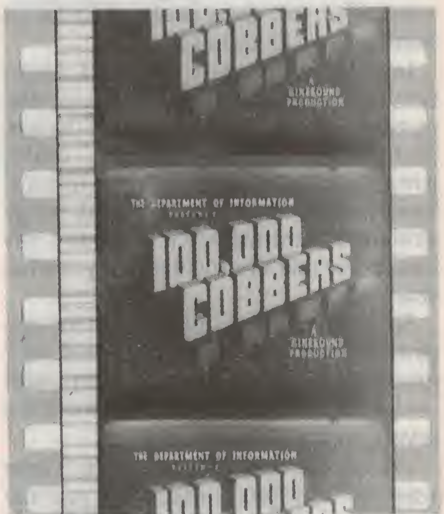
One other aspect mentioned by my friend was new to me. In those days, he said, shows equipped only with sound-on-disc were sometimes supplied with versions of new films along with discs dubbed from optical soundtrack prints. I quote: "Adding the limitations of a dubbed disc to those of an early optical print, the end result was often pretty lousy."

For what it is worth, my lasting impression of the sound from that ancient Janet Gaynor film was that it was any-



A Western Electric sound projector of the early 1930's, fitted with both an optical sound head for sound-on-film (beneath the picture head) and a synchronous turntable for sound-on-disc (beneath the lamphouse, at lower left).

Samples showing the two main types of optical sound-on-film track. Above is a 'variable area' track, while below is a 'variable density' track.



thing but crisp. And that to a lad from the bush, whose hearing was still unblunted by loud noise or the passage of time. Mind you, the problem could well have been due to the acoustics of the theatre itself.

I am reminded of a report by the late Don B. Knock, in *Wireless Weekly* for February 8, 1929. Commenting on optical sound films being shown at the once proud Sydney Regent theatre, he complained of a difficulty in following the words being spoken. He was uncertain whether to blame the acoustics of the theatre, muffling of the louspeakers by the screen or the actors' "very American intonation".

Fortunately, in hindsight, my grandfather's initial reluctance to get involved in talkies saved him from any involvement with the ill-fated disc system. In the meantime, my immediate family had moved to Sydney and I had taken a job in the electronics industry — building, testing and servicing radio sets. In the new situation, my boyhood experiences in Bargo were rapidly becoming but a memory.

It so happened, however, that one of the operators from the 'silent' era at Bargo had heard about a rundown suburban theatre that was being remodelled and re-equipped. In the process, its original projectors, which had been converted for sound, were being replaced and would probably 'go for a song'.

The operator's own situation had changed and, if Alf Hicks would buy the surplus gear, he was sure that it could be married to what Alf owned already, to provide acceptable results. No less to the point, reticulated AC was now available in Bargo and that would make the changeover much easier.

The course of events in the next few weeks I can only guess at, because I was 100km away and the people directly involved are no longer with us, to speak for themselves.

All I learned, by letter, was that they had bought and installed the surplus equipment and advertised a show for 'last Saturday'. Unfortunately, it had to be cancelled at the last minute because they couldn't get the sound system to work. They had postponed the show for a week so: could I possibly come up next weekend in time to fix whatever was wrong?

'Youth rushes in...'

Such is the optimism — and impetuosity — of youth that I duly turned up at my grandfather's place on the Friday evening. Complete with tools, meter and an assortment of wiring parts,

I was all set to 'fix' the amplifier next morning, ready for the advertised show in the evening.

Yes, I was told, they had picked the best out of their old equipment, and the 'new', and got it all working fine as far as the picture was concerned. It was just that they didn't know how to connect up the amplifier. To someone who built and tested radios all day, it should just be a matter of checking things over, connecting this to that and away it should go. After all, they reasoned, it had been working right up to the time it was dismantled.

Apprehension on my part may have been allayed by the fact that, some time previously, a senior member of the staff at Reliance Radio, where I worked, had been involved in setting up another do-it-yourself picture show in one of Sydney's northern coastal suburbs.

In reply to his many questions, members of the technical staff had been discussing things like projection lamps, transarcs, photoelectric cells, preamplifiers, power amplifiers, loudspeakers and so on. It was all pretty straightforward and even without a circuit, it shouldn't be too hard to spot what was wrong.

So, next morning, without undue apprehension, I accompanied my grandfather up into the projection booth — the first time I had been in there for several years.

Things had certainly changed. Gone was the wooden bridge between the projectors and the sliding lamphouse. Each projector now had its own arc — still operating from 80V DC, I was told, because it was available and easier to cope with at short notice than having to worry about AC arcs or lamp optics.

The DC drive motors bracketed to the front wall had also gone, to be replaced by AC motors attached to the projectors. Bolt-on sound heads and extended drive trains were in position and, I guess, different film gates to match the slightly smaller images on sound film.

How much else had been interchanged was lost on me because, after all, the projectors had been checked out and pronounced optically okay. My by-now urgent task was to check-out and 'fix' the amplifier.

Ah yes, the amplifier!

The amplifier was standing forlornly in one rear corner of the projection box — about the only place it could go in the restricted space. But even back in the 1930s, it looked like a relic of the electronic stone age!

It occupied two shelves in an angle-iron frame, about twice the size of a large filing cabinet and faced on all sides with steel wire mesh. The whole lot had been sprayed with so-called gold paint, long since faded and coated with grime.

On the top shelf, mounted on some sort of a plate and with exposed wiring, stood a couple of what looked like type 50 power triodes. They had input and output transformers, and were presumably driven by a 27 type triode and a 24 pentode voltage amplifier. On the lower shelf was the power supply — the whole thing with interconnecting leads and sundry other wires that appeared to have been cut when the gear had been removed.

Lying on top of the cabinet were two 12" (30cm) loudspeakers, the like of which I had never seen before. They were assembled on a pressed metal back plate, with holes that suggested that they were intended to hang on the wall like a picture. In the front was a heavy paper cone, with apex pointing outward, and also sprayed with gold paint.

At first glance they looked like ruggedly built old-time moving armature cone speakers, but closer inspection showed them to be back-to-front dynamics with the magnet and voice coil assembly accommodated inside the cone. Their age, their impedance, sound quality, sensitivity and condition could only be a matter for speculation.

But that was only half the story. I couldn't imagine a cabinet that size fitting between the two projectors in an average projection booth. In most cases, it could only stand where it was at the moment: right at the back. That meant that the shielded leads from the PE (photo-electric) cells would have been several metres long, with a prohibitively large shunt capacitance for the high natural circuit impedance.

What's more — and here was the killer — there was no sign of input connectors or controls of any kind on the amplifier. It was painfully obvious that the preamplifiers and controls must have been in one or two control boxes fixed to the front wall, or overhead, in the original projection booth. Where they were now was anybody's guess — but they were certainly not in Bargo!

A quick peep into one of the soundhead assemblies revealed a grimy looking interior and a PE cell about the size of an ordinary valve, fitted with a standard 4-pin UX base: almost certainly an RCA 868 or one of its many equivalents. The exciter lamps were also in place, apparently with their own supply transformers and wired to come on simultaneously with the associated drive motor. That was fine, but where was the missing link?

Having summed up the situation, I could only shake my head sadly and suggest that tonight's show would have to be cancelled also. It would have been job enough to get the basic amplifier working, without having also to contrive a control preamplifier from literally nothing.

The inevitable questions followed: If the original control system could not be located, could I build another one to suit? Was the old amplifier worth salvaging anyway?

In response to the last question, I explained that I would really need to check through the amplifier, extract the circuit and see whether it could be restored to working order. That would not be easy, with me employed full time in the city and the unwieldy old amplifier in a projection booth 100km away.

What about a new one?

Then would it be simpler to build a new amplifier? How much would it cost and how long would it take? This called for a bit of figuring on my part, but I reckoned that it would not be too costly a project if I used receiver type components, which were available over the counter and relatively inexpensive. It would take me about three weeks, built in a wooden rack to stand between the projectors and with a turntable on top to play records as part of the show.

Looking back now, I must have been crazy to stick my neck out that far. Yes, I had built, tested and serviced numerous receivers in a small factory situation — but I had never devised and built a private project of any kind, let alone a complete talkie sound system!

Back at home, I worked out the dimensions for a wooden rack that would be sufficiently deep and wide to accommodate a compact record player on top, and tall enough to bring the controls to a convenient height for the operator. My plan was to assemble the rack progressively over the period, allowing time for glue to harden and paint to dry.

The chassies and panels for the amplifier and power supply were bent up from 16-gauge aluminium — separate to minimise any risk of hum injection into the sound head preamplifier stage. They were then punched, drilled, lacquered and lettered in the way we did things in those days. This done, it was a matter of fitting the major components and getting

on with the wiring, working out the details on a stage by stage basis.

Unfortunately, I have no photographs of the finished amplifier, being blithely unaware that, for me, it would one day become an item of personal history. I didn't even draw layout and circuit diagrams, on the assumption that I would be the only person likely to service the gear in the forseeable future and, having built it in the first place, I wouldn't need them.

But that is a long time ago and, if I'd had to rely purely on memory, 50-plus years on, I'd have been hard put to do more than recall a few salient points about the design.

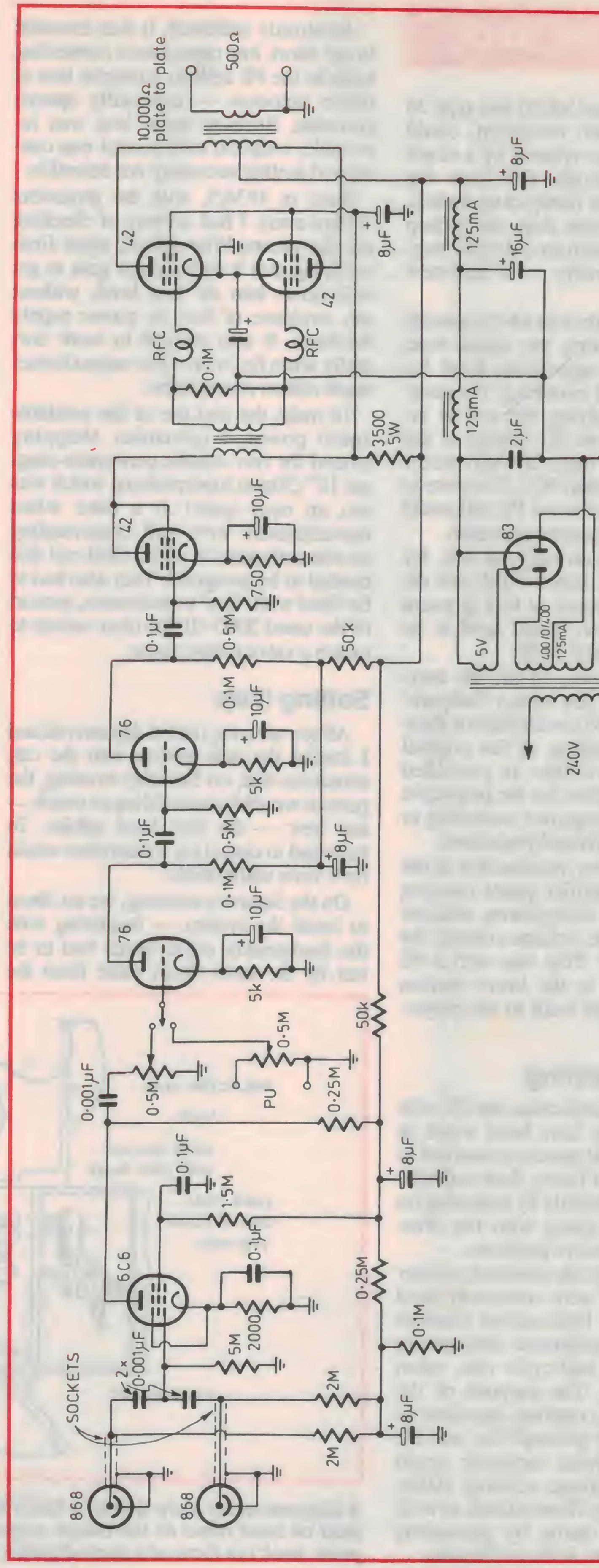
Circuit configuration

By sheer good fortune, however, when looking through an old lab notebook from my subsequent stint at the Amalgamated Wireless Valve Co, I came across an entry dated June 26, 1941. At the time, we must have been trying to cross-check the signal level to be expected from a PE cell in typical 35mm sound film projectors.

One entry, endorsed 'From FLS', records information that must have been obtained by Fritz Langford-Smith, possibly direct from Ray Allsop. Itself a fragment of history, it indicates that the valve line-up in one of Ray Allsop's current 'Raycophone' talkie amplifiers comprised a 1603 pentode preamplifier, 1603 triode connected amplifier, followed by another 1603 triode driving push-pull 2A3s through a 1:2.5 step-up transformer. (If memory serves me correctly, the 1603 was a low-noise equivalent of the 6C6, 6J7, etc). Calculations suggested an input sensitivity of 3mV RMS at full gain for full output, indicating an anticipated cell output comfortably above that figure.

More to the point in the present context is that, pasted into the notebook was a rough pencilled circuit endorsed 'Original amplifier for APH built about 1934/5'. As a further example of a functional amplifier, it was sketched only about six years after the event and would have been substantially accurate.

Built in 1934/5, the amplifier (see diagram) was obviously based on an RCA configuration which specified a triode-connected type 42 (6F6-G) driving two 42 pentodes in class AB2, through a step-down (class-B type) transformer; there was no provision for negative feedback. Maximum power output (5% distortion) into a 10,000 ohm P-P load was given as 19 watts — nominally higher than for either push-pull 2A3s or 50s.



Indicative of 1934 valve technology, this schematic shows the basic circuit configuration of the 'talkie' amplifier constructed by the author for the Bargo picture show. The component values are as used in the original, prior to the general adoption of the 'preferred value' system.

Ahead of this I had added two type 76 triodes which, with hindsight, could probably have been replaced by a single 6C6 (6J7-G) pentode, fed from the volume control and film/pickup switch. In those far-off 78rpm days, the pickup could either have been an old-style magnetic or — preferably — a then-new crystal type.

Ahead of this again was a 6C6 pentode preamplifier, boosting the signal from the PE cell to an appropriate level for volume control and switching. The resistive network supplying the cell is intended to provide an HT voltage at the lower end of the 2- meg cell load resistor of marginally less than 90V. If it were to exceed 90V, the gas in the PE cell could ionise, preventing normal operation.

A rough calculation suggests that, for typical half-power output (10W) and the C-taper volume control at half physical rotation, the PE cell would need to be delivering about 8mV RMS.

Because the purpose of the lab exercise was to derive just such a 'ballpark' figure, my pencilled circuit did not show the exact configuration of the original input system; whether it provided separate preamplifiers for the respective PE cells, with changeover switching or mixing for the individual projectors.

To the best of my recollection it did not, with the amplifier panel carrying only a two-way film/pickup selector switch and separate volume controls for records and films. This was with a PE cell input socket in the lower corners with short, shielded leads to the projectors on either side.

'Optical' switching

Based on this recollection, the PE cells would most likely have been wired as shown. Both would remain connected to the amplifier at all times, their cathodes being activated optically by switching on the exciter light along with the drive motor of the respective projector.

According to my lab notebook, exciter lamps at the time were commonly rated at 10V/7.5A, the high-current filament being meant to minimise temperature variations at the half-cycle rate, when driven with AC. The purpose of the deliberately small coupling capacitors to and from the 6C6 preamplifier, and the small cathode bypass capacitor would have been to attenuate residual 100Hz hum from the lamp filament and, as well, to assist speech clarity by attenuating possible bass boom in the auditorium.

As already indicated, it was essential to use short, low capacitance connecting leads to the PE cells to minimise loss of treble response — especially speech sibilants. Because some loss was inevitable, a top-cut tone control was considered neither necessary nor desirable.

Back in 1934/5, with the projectors 100km away, I had no way of checking out the preamplifier circuit, apart from verifying that it had enough gain to get well down into the hiss level, without any evidence of hum or power supply feedback. It also seemed to work normally when fed from a low output home-made ribbon microphone.

To make the best use of the available audio power, I remember shopping around for two reliable permanent-magnet 12" (30cm) loudspeakers, which was not an easy quest at a time when manufacturers were still concentrating on electrodynamics, with a field coil that needed to be energised. They also had to be fitted with 'line' transformers, instead of the usual 5000-10,000 ohm variety to match a valve output stage.

Setting it up

All too soon the fateful day arrived and I loaded the new system into the car, conscious that, on Saturday evening, the patrons would be assembling to watch — and hear — the first local talkies. To have had to cancel for a third time would have been unthinkable!

On the Saturday morning, we set about to instal the system — beginning with the loudspeaker cable which had to be run by the most direct route from the projection box, through the ceiling rafters to the wall behind the screen.

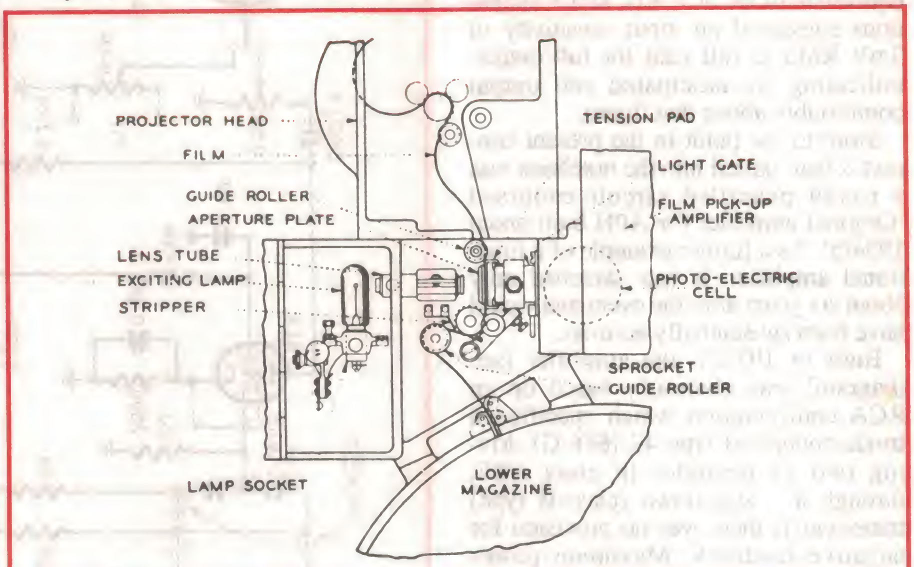
I left that job to someone else, while I mounted the loudspeakers on a baffle board. This was bridging a hole which had been cut in the wall backing the screen and separating the 'supper room' from the hall proper. I had specified that the rear had to be enclosed with a large padded box, both to confine the noise and to prevent the cones from being blown out of their housing by a blast of westerly wind through the open back door!

That done, I set about checking and connecting the leads to the loudspeakers and to a terminal strip and cable plugging into the rear of the amplifier. A monitor loudspeaker also had to be set up in the projection box, with its own preset level control.

The amplifier was duly 'fired up' and the building re-rechoed to the promising sound of Reginald Dixon at the Blackpool organ playing *Blaze Away* — a Regal-Zonophone record that seemed appropriate for the occasion. In those days of 78rpm discs, the music sounded clean, with volume to spare. If the films sounded like that, we'd all be happy!

The next job was to attach new cables to the soundheads for connection to the amplifier — and here progress slowed to a crawl. The existing cables were 'gooey' with oil, as also was the inside of the PE cell enclosure and the anti-vibration foam rubber pad supporting the socket. Over the years, oil had obviously seeped into the soundhead from the optical projection mechanism above.

The thick layer of oil and grime may



A diagram of an early Western Electric 'pull through' sound head, similar to the kind of head fitted to the Bargo projectors. In some units the sound 'aperture plate' took the form of a curved guide, making a pressure shoe unnecessary.

well have affected the optical path, as well as making it difficult to attach the new leads. No less to the point, in a high impedance device like a PE cell, with an anode load of 2 megohms and an anode current of a few microamps, a leakage path of grease and grime could have a devastating effect on the output signal.

There was nothing for it but to dismantle and degrease the entire PE cell assembly, and substitute a length of new, low capacitance microphone output cable to conserve as much as possible of the top-end frequency response. I was also uncomfortably aware that cables carrying low-level DC polarised signals can be microphonic.

By the time I had cleaned, re-assembled and connected up both soundheads, the sun was dipping rather low on the western horizon and there was some urgency about the final step of loading up a spool of film, starting the engine out the back to provide an adequate DC supply for the arcs and checking to see whether the whole system would run.

No time to spare

Fortunately it did. But by the time we had checked both projectors, decided on typical settings for the volume control and set everything up ready for the night's entertainment, there was time only for a quick scrub-up and meal before it was on with the show.

Instead of a solo pianist of the silent era, this one opened with *Blaze Away* on Wurlitzer organ, followed by *Parade of the Tin Soldiers* — or was it *TeddyBears' Picnic*? Then the lights suddenly went out and on the screen flashed a real talking picture.

A few minutes later, I left the operators to it and sank on to (not into) a wooden seat in the auditorium. For one day, I'd had just about enough. Suddenly an express loco appeared on the screen roaring straight towards us. Roaring? Yes, *roaring* — and with a deafening blare from the steam horn atop the boiler.

It was the sweetest sound I'd ever heard. Perhaps because of it, I didn't hear the sigh of relief from my grandfather in his favourite spot, just inside the doorway leading to the ticket office. After two cancelled shows, one could scarcely begrudge him a sense of relief.

The amplifier continued to work without a hitch for months — with one amazingly fortuitous exception. On a particular weekend, I visited my grandparents on a purely social call and volunteered to have a quick look at the amplifier while on the spot. Imagine my surprise to find that it was completely dead, even though it had been operating normally right up to switch-off the previous Saturday. Fortunately, it proved to be a minor fault, easy to correct — but the experience came as a shock to Alf Hicks. He commissioned me on the spot to build a standby amplifier, which was duly fitted into spare space in the amplifier rack. It was essentially an electrical duplicate of the original and was run interchangeably with it, to ensure that both amps remained operative.

Problem with trains

In the mid 1930s, without the competition of television, the sheer novelty of local talkies ensured their success. But gradually, the patrons became more critical regarding the presentation.

The main southern rail line to Melbourne ran right past the front door, complete with two goods sidings, a steep grade, water towers for the steam locos and an ash pit where the crew cleared the gratings. Passing trains were problem enough, but when shunting and water stops coincided with tender moments in the film, the effect was distracting to say the least.

So also was a thunderstorm and/or pelting rain on the galvanised iron roof overhead. Even at the best of times the sloping roof posed an acoustic problem, with echoes picked up from the loudspeakers and reflected back to the audience with just enough delay to compromise the diction.

I suggested to Alf Hicks that some form of ceiling would ease all these problems, but the idea was much easier for me to suggest than for him to execute.

These days, I would have recommended a line source loudspeaker system — a four-driver vertical array — to beam the sound out over the audience but, if line source systems had been conceived at the time, I didn't know about them.

Some time later, for an entirely different reason, Alf Hicks built a decorative proscenium over the front of the stage, about four metres (10-12') in front of the screen. I suggested that the loudspeakers could logically be accommodated in the top face of this, where they would be that much closer and inclined downwards towards the the audience. The echo effect from the roof might well be reduced. In fact, the rearrangement did help quite significantly.

One other problem led to a rather startling result. As described in the last article, the silent pictures had always been shown against the background of a regular 'bom-bom-bom' of the single cylinder engine driving the generator. With talkies, it was just one more sonic distraction, especially when Alf Hicks elected to use the larger diesel. Minor modifications to the exhaust system made little difference.

Dramatic solution

Irritated by the complaints, Alf Hicks decided to fix the problem once and for all. He dug a large hole just outside the engine shed and buried in it a 40-gallon drum, as used for bulk storage of fuels or other liquids. Into it he led the exhaust pipe from the diesel engine, along with a separate pressure relief pipe into the open air. The hole was then filled and tamped down.

On the following Saturday, the engine was started as usual and cycled from petrol to kerosene and then to diesel. It certainly was much quieter.

One can only assume that, part way through the evening, the engine picked up speed — causing the governor to interrupt normal operation. Presumably, the engine pumped a number of unburnt charges of fuel-air mixture into the drum, which were then triggered by the next active exhaust discharge.

Sufficient to say that the night was suddenly rent by the most enormous explosion, followed by an open exhaust. The 40- gallon drum had been blown apart and its overburden of earth scattered to the winds. Thereafter the smaller engine did most of the work on Saturday nights!

Final intermission

Hicks' Bargo talkies have long since closed down, but what happened to the equipment, I don't really know.

My grandfather really did retire, long after the calendar said he should. He ceased to be active in the picture show, sold his home and hall and spent his closing years in suburban Sydney. The projection equipment, I was told, was bought by one of his former operators, who had ideas of either setting it up elsewhere or taking it on the road as an itinerant show. Either way, it would long since have fallen silent.

My direct involvement with 35mm movies began and ended with that show, but it left me with a hands-on feeling for the technology which I could never have obtained from books alone. It has also left me with an appreciation for the refinements that have found their way into the art — ranging from widescreen, stereo sound films in your local cinema to the enveloping sight and sound of the specialised hi-tech theatres dotted around the world. ■

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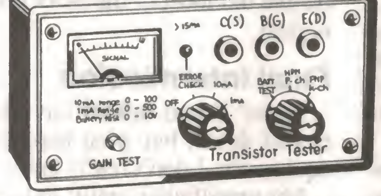

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- 30kHz selectivity at -60dB
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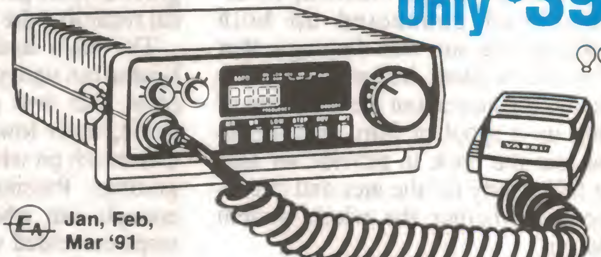
At this price you can afford to take the challenge! Kit includes all components, hardware, heatsink and a pre-punched silk screened front panel. Microphone is not supplied. YAESU D-2110 or D-2105 are recommended.

Cat K-6400

Only $399

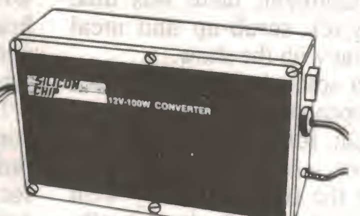


EA Jan, Feb, Mar '91

12VDC 100 Watt Converter

Ever wished you had the power of your home stereo in the car? Well now you can! This compact inverter will power equipment up to 100 watts. That makes it ideal for our 50 watt and 100 watt amplifier modules. It has temperature & current overload protection plus low voltage shut down to prevent your car battery going flat. This kit is supplied complete including case.

Cat K-3235



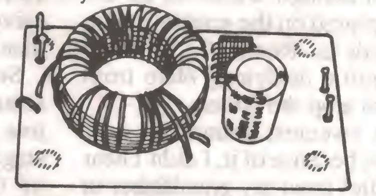
$129

SILICON CHIP DEC '90

1.5V to 9VDC Converter

Frustrated at how quickly your 9 volt batteries go flat? Then switch over to more cost efficient 1.5 volt cells with this 1.5 to 9 volt converter. It uses just 3 components and fits on a small PC board. This is a short form kit — PCB and components only.

Cat K-3230



EA NOV '90

$14.95

With Instructions & Parts List!

Assorted Circuit Boards

Here's a great way to use up leftover components! These assorted projects include 3 to 4 boards with detailed instructions and parts list — parts which you may already have! Some projects even include front panels.

Cat K-9090 **$19.95** Cat K-9095 More complex boards **$29.95**

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Kits marked with this symbol involve mains power wiring. Take extreme care when working with this equipment.

Degree Of Simplicity Simple Intermediate Detailed

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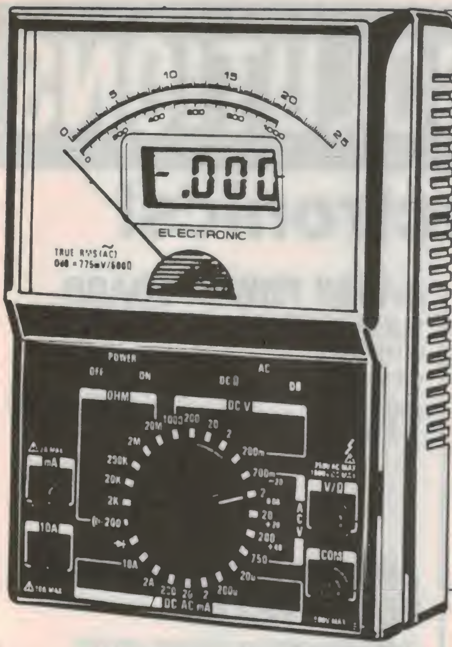
B1100/PB



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With true RMS!

COMBINED ANALOG/ DIGITAL MULTIMETER

If you've ever wished for an accurate digital meter with the readability of an analog meter then here is the solution-- a digital multimeter with a large 3½ digit display combined with a full sized analog meter with mirrored scale! Unit comes complete with probes and soft carry case.

Ranges:

- DCV 200mV, 2V, 20V, 200V, 1000V
- ACV(rms) 200mV, 2V, 20V, 200V, 750V
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- Resistance 200, 2k, 20k, 200k, 2M, 20M ohms
- dB -45dB to +50dB (4 ranges)
- Audible continuity
- Diode check

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Cat Q-1700

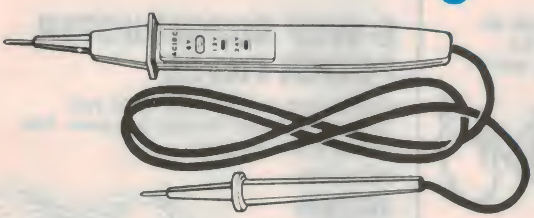
MULTIMETERS

6-24V VOLTAGE TESTER

Checks both AC and DC voltages within the range of 6, 12, or 24 volts.

Cat Q-1532

$6.95



110-500V VOLTAGE TESTER

Checks for voltages in the range of 150, 300, and 500 volts DC or 110, 220, and 380 volts AC

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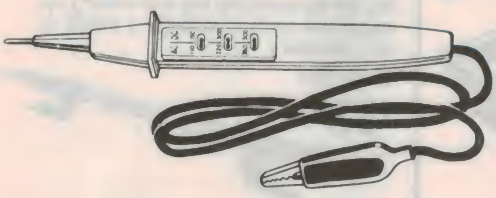


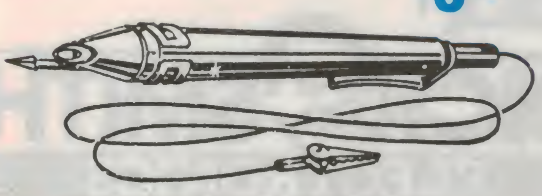
It doubles as a Flashlight!

CONTINUITY TESTER

Made from solid steel, this handy continuity tester can check for short circuits and circuit breaks, test diodes plus it doubles as a handy flashlight!

Cat Q-1536

$6.95



With Built-in Logic Tester!

PROBE TYPE DIGITAL MULTIMETER

This would have to be the smallest, handiest DMM you'll ever have the chance to buy! It features Data Hold, fixed and auto Ranging, plus a full 3½ digit LCD display.

- 200mV to 500V range
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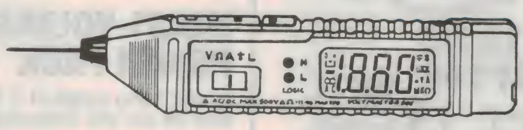
- Auto Polarity indication
- Diode and continuity testing
- AC/DC Current up to 200mA
- Soft carry pouch

$59.95

Cat Q-1560



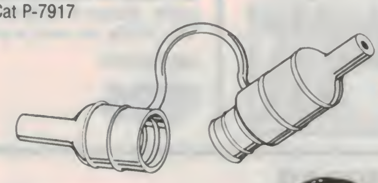
WATERPROOF FUSE HOLDER

This in-line fuse holder suits 3AG(6.35x31.8mm) fuses and is ideal for auto and marine work or in any harsh environment. Crimp connections make wiring a breeze and the large eyelet is designed to anchor the fuse holder to the wiring loom.

- Rated (max) 32V @ 30A
- Resistant to water, salt spray and ultraviolet light
- -40 to 150 deg.C temperature range
- Withstands many organic solvents as well as rigourous shock and vibration

Cat P-7917

$5.95



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B1100/P2

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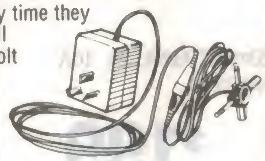
IN-SITU NICAD BATTERY CHARGER

You don't have to pull the batteries out of your equipment every time they need recharging. Will recharge 7.2 to 12 volt cells.

Cat M-9517

$17.95



200mA AC TO DC POWER ADAPTOR

This battery eliminator produces 3, 6, or 9 volts and includes a universal connector to suit most appliances

Cat M-9525

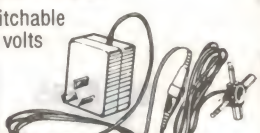
$18.95

300mA AC TO DC POWER ADAPTOR

300mA of current switchable from 3 through to 12 volts

Cat M-9526

$19.95

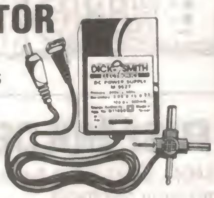


500mA AC TO DC POWER ADAPTOR

500mA switchable through 3, 4.5, 6, 7.5, 9, & 12 volts

Cat M-9527

$21.95

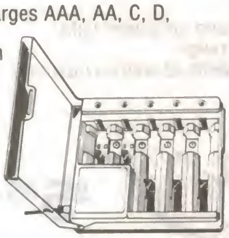


THE DSE CHARGING CABINET

8 batteries at once! Charges AAA, AA, C, D, and 9 volt batteries. Indicator lights for each cell, reverse polarity protection, and test meter.

Cat M-9505

$39.95



12V PLUG PACK

Supplies 12 volts DC at 1 amp

Cat M-9570

$24.95

900mA 16V POWER SUPPLY

Now there's no need to fit a power transformer inside your project! Suitable for most 12 volt DC applications.

Cat M-9567

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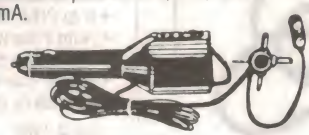
CAR VOLTAGE CONVERTER

Mains adaptors are fine but what do you do in the car? This converter plugs into the cigarette lighter and produces 6, 7.5, and 9 volts at 800mA.

Cat M-9584

$16.95



MULTI-VOLTAGE POWER PACK

A hefty 1 amp supply at 3, 6, 9 & 12 volts. Ideal for use with alarm systems.

Cat M-9530

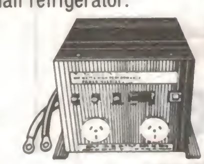
$39.95

HIGH PERFORMANCE POWER INVERTOR

Converts 12 volts DC to 240 volts AC at 600 watts. Attach it to your car battery to run TVs, VCRs, or even a small refrigerator.

Cat M-5000

$525

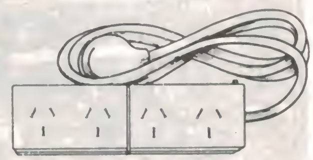


4-WAY POWER BOARD

With built-in overload protection. Top value at this price.

Cat M-7114

$12.95

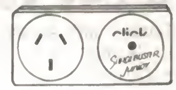


JUNIOR SURGEBUSTER POWER FILTER

Protect your sensitive computer and Hi-fi gear against harmful power surges and spikes

Cat M-7152

$39.95

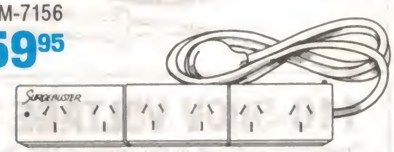


6-WAY SURGEBUSTER POWER FILTER

Now you can save by plugging all your sensitive equipment through one power filter without double adaptors

Cat M-7156

$59.95

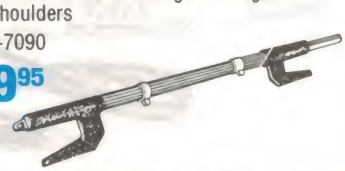


CORD STICK

Pop out the extension rod and winding up long power cords is no longer a weight on your shoulders

Cat M-7090

$19.95

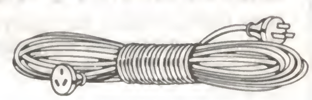


5m EXTENSION LEAD

10 amp beige coloured lead

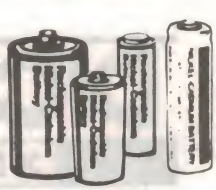
Cat M-7074

$7.95



DSE HIGH GRADE NICAD RECHARGEABLE BATTERIES

Cat S-3300	AA	$3.95
Cat S-3301	C	$9.95
Cat S-3303	D	$9.95
Cat S-3305	AAA	$3.95



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COMPONENTS

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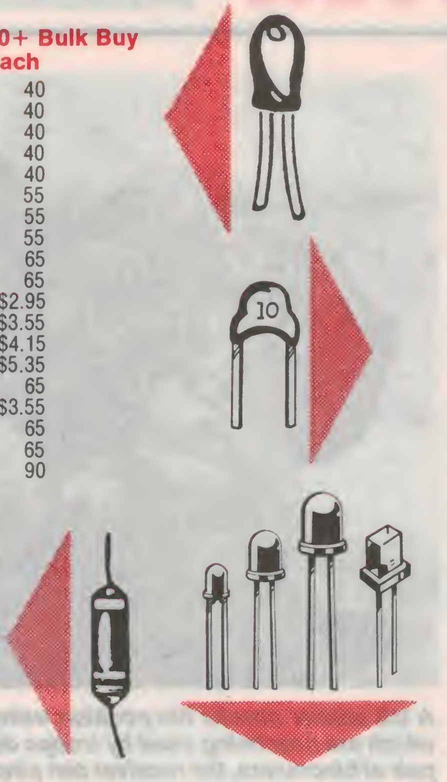
TANTALUM CAPACITORS

Cat No.	uF	Volts	Each	10+ Bulk Buy Each
R-4700	0.1	35	80	40
R-4705	0.22	35	80	40
R-4710	0.33	35	80	40
R-4715	0.47	35	80	40
R-4720	1	35	80	40
R-4730	2.2	35	$1.10	55
R-4735	3.3	35	$1.15	55
R-4740	4.7	35	$1.25	55
R-4745	6.8	35	$1.45	65
R-4750	10	25	$1.45	65
R-4752	22	25	$5.95	$2.95
R-4754	33	25	$6.95	$3.55
R-4756	47	25	$9.95	$4.15
R-4758	68	25	$12.95	$5.35
R-4760	22	16	$1.75	65
R-4762	100	16	$6.95	$3.55
R-4765	33	10	$1.75	65
R-4770	47	6.3	$1.75	65
R-4775	100	3	$2.25	90

250V POLYSTYRENE CAPACITORS

Cat No.	pF	Each	10+ Bulk Buy Each
R-2807	33	90¢	50¢
R-2809	39	90¢	50¢
R-2811	47	90¢	50¢
R-2813	56	90¢	50¢
R-2815	68	90¢	50¢
R-2817	82	90¢	50¢
R-2819	100	90¢	50¢
R-2821	120	90¢	50¢
R-2823	150	90¢	50¢
R-2825	180	90¢	50¢
R-2827	220	90¢	50¢
R-2829	270	90¢	50¢
R-2831	330	90¢	50¢
R-2833	390	90¢	50¢
R-2835	470	90¢	50¢
R-2837	560	90¢	50¢
R-2839	680	90¢	50¢
R-2841	820	90¢	50¢
R-2843	1000	90¢	50¢



50 VOLT MONOLITHIC CERAMIC CAPACITORS

Cat No.	pF	Each	10+ Bulk Buy Each
R-1981	10	30¢	15¢
R-1982	15	30¢	15¢
R-1983	22	30¢	15¢
R-1984	33	30¢	15¢
R-1985	47	30¢	15¢
R-1986	68	30¢	15¢
R-1987	100	30¢	15¢
R-1988	120	30¢	15¢
R-1989	150	35¢	20¢
R-1990	220	35¢	20¢
R-1991	330	40¢	20¢
R-1994	470	40¢	20¢
R-1995	680	45¢	25¢
R-1996	1000	30¢	15¢
R-1997	1500	30¢	15¢
R-1998	2200	30¢	15¢
R-1999	3300	30¢	15¢
R-2002	4700	30¢	15¢
R-2003	6800	35¢	20¢
R-2000	0.01uF	35¢	20¢
R-2004	0.015	40¢	20¢
R-2005	0.022	40¢	20¢
R-2006	0.033	40¢	20¢
R-2007	0.047	45¢	25¢
R-2008	0.068	50¢	25¢
R-2001	0.1	50¢	30¢
R-2180	0.15	35¢	20¢
R-2181	0.22	45¢	25¢
R-2182	0.33	55¢	30¢
R-2183	0.47	60¢	35¢
R-2184	0.68	65¢	35¢
R-2185	1uF (25v)	70¢	40¢

3mm LEDs

		Each	10+ Bulk Buy Each
Z-4077	Red	35¢	20¢
Z-4079	Green	35¢	20¢
Z-4081	Yellow	35¢	20¢
Z-4083	Orange	35¢	20¢

5mm LEDs

Z-4085	Red	50¢	30¢
Z-4087	Green	50¢	30¢
Z-4089	Yellow	50¢	30¢
Z-4091	Orange	50¢	30¢

10mm LEDs

		Each	10+ Bulk Buy Each
Z-4060	Red	95¢	55¢
Z-4061	Green	95¢	55¢
Z-4062	Yellow	95¢	55¢

2x5mm LEDs (Rectangular)

Z-4093	Red	60¢	35¢
Z-4095	Green	60¢	35¢
Z-4097	Yellow	60¢	35¢

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B1100/P4

Silicon Valley NEWSLETTER

First superconducting transistor claimed

Researchers at the University of Wisconsin have announced the development of what is claimed to be the world's first functional high-temperature superconducting transistor.

The transistor was developed in cooperation with the Sandia National Laboratory in New Mexico, and the US Department of Energy. It operates at about -207°C, so that it will function at the temperature of liquid nitrogen.

The researchers created the transistor by etching it into a thin film of thallium and superconductive copper oxide. The main difference between the new device and conventional transistors is said to be that it uses an input current to control output voltage, rather than output current.

If the new devices prove reliable and able to be mass produced, they could revolutionise the design of many electronic systems — including supercomputers, military communications systems, ultra-sensitive sensors and analytical instruments.

A US soldier checks his position using a Trimpak GPS receiver, thousands of which are now being used by troops deployed in the Saudi desert. The size of a pair of binoculars, the receiver can pinpoint its location on the globe to within 50 feet. Trimble Navigation also sells a civilian version, 'Transpak', for US$4000.

Toshiba first to sign with TI

In what is expected to be the first of a series of major chip royalty agreements, Toshiba has signed a 10-year semiconductor technology licensing agreement with Texas Instruments — following the decision earlier last year by Japan's Patent Office to grant TI's patent for the invention of the IC (in 1958!). The Toshiba agreement is expected to gross TI between US$60 and $100 million a year in royalty payments.

Industry observers were surprised at the relative speed with which Toshiba came to terms with TI. The agreement sets the stage for similar agreements with all of the major Japanese chip companies. When completed, TI's DRAM and IC chip patents are expected to bring the firm as much as US$1.1 billion annually.

During the past three years, TI has aggressively pursued royalty payments from companies using its DRAM and other technologies. The effort began in 1986, when the US International Trade Commission ruled in TI's favour on a complaint that the Japanese were infringing on the company's DRAM patents. One by one, the Japanese firms quickly settled with TI to avoid having their products barred from the vast US market.

The DRAM agreements have since netted TI more than US$650 million in royalties.

In Tokyo, a spokesperson for Toshiba commented that the new agreement with TI "hurts, but it won't affect our competitiveness".

Justice Dept. tries to block Semi-Gas sale

For the second time in history, the US Government has moved to block the sale of a high-tech company to Japan. The US Justice Department has announced that it will file an anti-trust suit to block the proposed sale of tiny San Jose-based semiconductor equipment maker Semi-Gas to Nippon Sansa.

The controversy over the sale of Semi-Gas has been brewing for just on a year. Semi-Gas is the dominant supplier of gas containment systems which are used in the chip manufacturing process, and the company is playing a critical role in efforts by the Sematech chip manufacturing consortium to develop advanced chip production technology.

Early in 1990 President Bush refused to block the sale. But the Justice Department has been conducting its own investigation since then, and has decided that the sale violates US anti-trust laws. Nippon Sansa already owns Matheson Gas Products, which is Semi-Gas's closest competitor in the market for gas-containment systems.

The Justice Department's decision is seen as signalling a new direction in Administration policy. Presumably the Government will use anti-trust laws to prevent any further 'hollowing out' of critical high-tech industries such as chip equipment manufacturing.

"This sends a signal to foreign competitors that the US Government is interested in keeping American companies

American", said Sematech's chief administrative officer Peter Mills.

National Semi reports profit — at last

Santa Claus delivered a long and very eagerly awaited Christmas present to National Semiconductor's president Charlie Sporck: a quarterly operating profit, the first one in Sporck's 18-month effort to return the company to profitability.

National has announced a second-quarter net profit of US$3.5 million, a huge turn-around from the whopping US$165.5 million loss in the first quarter. Sales for the quarter rose from $417 million a year ago, to $427 million.

"The significant improvement in operating performance in this quarter reflects the benefits resulting from the restructuring activities the company undertook in August. We continue to reduce fixed costs, in order to further improve the company's financial performance", Sporck said.

Frisco passes toughest VDT law

In what is easily the toughest VDT safety law yet introduced in the United States, the San Francisco Board of Supervisors has voted 8:1 in favour of sweeping legislation, likely to be followed in many other cities across the US. The law will be applied to any worker within the city's boundaries who uses a computer for a large proportion of their daily activities.

The law will require the use of detached keyboards, ant-glare screens and special lighting. It mandates the use of ergonomic workstations, including adjustable chairs and rests for feet, arms and wrists. It will also forbid workers to work on a computer for more than two hours without a 15-minute break for relaxation or performing non-computer related job activities.

Violators of the ordinance face fines of US$500 per day.

The local business community had strongly opposed the measure. It is estimated that the law will require local businesses to spend between US$40 and $60 million to comply with the law. Some will face a particularly high cost if they have to replace a large number of monitors that don't currently feature anti-glare screens.

City Supervisor Nancy Walker, who initiated the legislation, said the bill reflects concern for an alarming increase in the number of VDT-related worker illness and injury reports. "We are once again on the cutting edge, and we are taking some heat for that from business", Walker said, referring to the tough anti-smoking ordinance adopted two years ago.

Go-Video seeks to block MCA merger

Go-Video, 'the mouse that roared' once before, has again stepped into the spotlight with an effort to block one of the biggest corporate take-overs in American history. The tiny Scottsdale, Arizona company has filed an anti-trust lawsuit with a Federal court in Phoenix, seeking to block the proposed US$6 billion acquisition of MCA by Japan's Matsushita.

The world's first and as yet only manufacturer of a dual-deck VCR, Go-Video filed an anti-trust suit earlier last year against six of Japan's largest consumer electronics firms (including Matsushita), claiming that they had conspired to keep its product off the market. The latest suit is a spin-off from the earlier one, with Go-Video claiming that the acquisition of MCA (which includes Universal Studios) is part of a conspiracy by Matsushita and Sony to monopolise the consumer electronics entertainment market.

The suit asks the court to block the sale on the grounds that such a strategy violates US laws designed to encourage competition.

Several of the companies defending the original suit have apparently agreed to out-of-court settlements, including the Electronics Industry Association of Japan and Korea's Samsung. The latter firm is now producing the Go-Video VCR, which retails in the US for around US$1100.

Space-based 'hacker'

NASA astronaut Ronald Parise has qualified for the title of the first space-based computer 'hacker', after using his Grid laptop computer to communicate with earthbound computer hobbyists, during a flight of the Columbia space shuttle in December. The laptop was hooked up with a transceiver on board the shuttle, allowing Parise to exchange messages directly with other hobbyists equipped with ham-radio equipment.

Unfortunately problems with the deep-space observatory being carried by the shuttle kept Parise and the rest of the crew far more occupied than had been anticipated, limiting his opportunities to spend time 'hacking'. The laptop is normally used for a number of non-critical flight functions, including indication of the shuttle's current orbital position.

More Trimpacks for the Gulf

With very few geographic features to tell US troops where they are in the Saudi desert, the Trimpack portable global positioning system from small Sunnyvale-based company Trimble Navigation has apparently been a big hit. The firm has received its third order from the Pentagon, this time for another 2300 units — worth a total of US$12 million.

The small system is about the size of a pair of binoculars, and uses the signals from three orbiting GPS satellites to tell a soldier his exact location on the globe, with an accuracy of closer than 50 feet.

The current Pentagon order follows one for 1200 units, placed shortly after the Kuwait invasion last August. The military had already purchased 1000 units before that.

With all the attention that his product has received in the media, company president Charles Trimble says his product will now become more readily used in commercial markets — including trucks, cars and boats. ■

COURT VOIDS dBASE COPYRIGHTS

US District Court Judge Terry Hatter, presiding in Los Angeles, has voided the copyrights of Ashton-Tate's dBase software, and thrown out an Ashton-Tate infringement lawsuit against two dBase clone makers — stating that the firm had deceived US Copyright Office officials.

Ashton-Tate filed the suit back in 1988, against Fox Software and the Santa Cruz Operation, after they began marketing dBase look-alike programs. But Judge Hatter has ruled that the dBase copyrights were invalid, because the company based its program on the JPLDIS database program developed in the late 1970s at the NASA Jet Propulsion Laboratory. Ashton-Tate 'repeatedly failed' to mention this to the Copyright Office, said Hatter, in an unusually strongly-worded opinion.

Hatter dismissed the case against Fox and Santa Cruz 'with prejudice', which means that Ashton-Tate cannot refile the case in a different court.

Moffat's Madhouse...

by TOM MOFFAT

The ultimate 'black box'

How amateur is amateur radio? Less and less with every day that goes by, I'm afraid. For years now, died-in-the-wool amateur operators have bemoaned the fact that hams have turned into a breed of 'appliance operators' — masters of the black box.

There are arguments for and against this trend. For, in that amateur operators can now buy, off the shelf, technology that wouldn't have been available to even the best-heeled commercial or government operators as recently as five years ago. The argument against black boxes is that so-called 'technically competent' amateurs have now lost the ability to repair their own equipment, let alone build it.

Modern amateur technology has followed commercial practice. There's less reliance on HF frequencies and direct communication, and more on VHF and repeaters. And waiting in the wings — satellites. Amateurs have been in the forefront of satellite technology for years, even building special satellites for amateur use only. But late in 1989, for the first time on a national basis, amateurs relied on commercial circuits on a government-owned satellite to carry out amateur communications.

Jamboree on the Air

The occasion was the annual get-together between scouts and radio amateurs — the Jamboree on the Air. Traditionally this has involved setting up HF radio gear in scout halls or at bush camp sites, so scouts and guides could speak with their counterparts all over the world. This was real steam-radio stuff: fading signals, noise and whistles and "could you repeat your name, please?". Successful communication was a chore, but there was the thrill of the chase and satisfaction when contact was made.

This time Aussat chipped in with free satellite circuits, to interconnect two-metre amateur repeaters with those of other Australian capital cities and with New Zealand. This eliminated completely the need for all those messy HF antennas, the need to climb trees to string wires or to erect temporary masts.

Contact could now be made to a city thousands of kilometres away with a simple one watt walkie-talkie, or a mobile rig in a car that looks much like (dare I say it?) a CB set.

My goodness, didn't the band go wild! The scouts had the time of their lives — but even more so, the amateurs in charge of the stations. Many held limited licenses, meaning they could only use VHF or UHF over short ranges. Now they could talk to a fairly good chunk of the South Pacific.

Real discussion

This was fascinating to listen to, and to take part in. On the HF bands overseas contacts many times amount to little more than exchanging callsigns and signal reports, and maybe a quick weather report. They last just a few short minutes, or when a contest is on, a few seconds. But on this temporary two-metre link via Aussat, people wanted to talk like *people*, instead of radio hams. What's it like where you live? What are the industries there? What's the climate like? What do you like best about the place? Tell me about your family. How far are you from Sydney/Perth/Brisbane?

The Aussat link was meant to be for the Jamboree, but once the scouts had bedded down for the night the hams 'went at it' until the early hours of the morning.

It all reached a climax here in Tasmania when we were patched through to New Zealand — the whole of the country, since they have a permanent UHF linking system to interconnect their major repeaters. I've always felt deep down inside that Tassie might be better off as part of New Zealand, and this experience reinforced that: hams on both sides of the Tasman, particularly those VHF- bound, hit it off like long-lost friends.

The Kiwis all seemed so proud of their home areas, and so happy to talk about them. Same went for the Tasmanians, and there were lots of promises made to tour each other's islands sometime in the future. On this end there was one fellow who was obviously re-living a New Zealand holiday he'd had a couple of years earlier. Another Hobart amateur of many years standing said the whole Aussat link business was the most thrilling thing that had happened to him since he put his first signal on air. At the other end of the scale was a charming Kiwi lady named Jane, who'd just got her VHF-only licence and suddenly found she could make new friends all over Tasmania.

The fun came to an abrupt halt at 10 o'clock on the Monday morning, when the temporary link was to be pulled down. The fellow in charge of it gave a few minutes warning, and that set off a flood of cheerios and goodbyes and promises to meet again. It reminded me of a ship sailing away, with passengers throwing streamers to those on the dock and both holding onto them until the bitter end. Then the Kiwis were gone.

A breakthrough?

The general opinion: what a great technological breakthrough! But was it?

In reality, what we were doing was talking on a telephone circuit. Any of us could have done the same thing (provided we were willing to pay, of course) by simply picking up a phone and dialling a few numbers.

This bothers me somewhat. A lot of people said "wouldn't it be great if we could have this all the time". If we did, it would most likely signal the end of amateur radio as we know it. The JOTA weekend was significant because it was the first time as far as I know that one form of amateur radio depended upon a commercial facility, the Aussat satellite, in order to operate.

An important principle of amateur radio is being able to provide communications totally independent of

anyone else. Such communications should be able to continue regardless of whether a satellite is working or not. Amateur communication should exist despite loss of phone lines, mains power, or in times of flood, cyclone, bushfire, or earthquake. If our antennas fall down in a storm (*a la* Cyclone Tracy in Darwin) we should be able to get them back up again forthwith and carry on with battery power.

San Francisco quake

By pure coincidence, the ABC showed a documentary about the big San Francisco earthquake of 1989, at the same time the JOTA-Aussat link was in full cry. The earthquake caused great fissures in the streets and tore many telephone cables to shreds, including those feeding police radio bases. The police radio network fell to bits at the time it was needed most, and television broadcast stations became the only way to disseminate essential information. And of course that was one-way only.

What happened to the radio amateurs in San Francisco? Surely they had some disaster plan set up. Even amateurs in piddly little Hobart are prepared to step in if the radio networks here go bung. There's a register kept of who has what equipment, who can operate battery power, and who can operate on HF or VHF from their cars. There are periodic exercises just to make sure all this stuff works.

The point is that all this amateur gear can work independently of anything — no power supplies, no phone lines, no satellites. Providing both can still stand up and they haven't been nuked or something, operator A will be able to talk to operator B within minutes of any disaster.

I wonder what did happen in San Francisco. I've seen a lot of training films over the years, showing what great and modern 'public safety' communications they have in America, and particularly California. You press a button here, a car gets dispatched there. There are radio bases and repeaters on every hilltop, with in-car polling systems so you always get to communicate through the strongest station — a bit like cellular phones.

But when the crunch came, literally, the whole thing went haywire. Maybe they just technologied themselves to death. On reflection it looks like San Francisco's police simply couldn't talk with each other directly, since all signals had to go through some kind or repeater or other. In normal times a cop with a handie-talkie could talk to his mate several suburbs away. But with the repeaters kaput, they could be standing 50 metres apart and still be unable to communicate.

Their radios should have had some simplex channels — simple one-frequency operation where you can talk directly to someone else nearby. But did they have simplex channels? And if they did, did the police users know enough to switch to them when the main network went down? Or did they just say "the radio's not working" and give up?

'Direct' communication used to be the only choice. When I first moved to Tasmania many years ago, the Hobart police headquarters had two big towers on top, with a wire antenna strung between them. This was connected to an HF transmitter and receiver within the building that could communicate around the state, or with Melbourne, by — wait for it! — Morse code. That system would have been just about indestructible — no repeaters, no phone lines, no nothin'. But now it's gone.

Common channels

The police and other emergency networks in Tassie all have their links and repeaters now, but they have also arranged simplex channels so cars and hand-portables can communicate directly. They've even gone further and put common channels in units of the police, fire brigades, the forestry commission, State Emergency Service, and any other services that will come into play if there's a natural disaster.

This scheme came about as a direct result of the 1967 bushfires that devastated the southern half of Tasmania. Back then every service had its own channel, jealously guarded. And when the police car on one side of the fire wanted to talk with the fire unit on the other side, it just wasn't on. Nowadays, a quick flick of the channel switch and everybody can talk with everybody else, free of repeaters or any other aids. Are other states thinking this way?

The experts tell us terrestrial repeaters will eventually be replaced with direct-access satellites. On the surface this sounds great, but what happens when the satellite goes bung? It does happen, you know, regardless of what satellite promoters say. How many times have you been trying to watch something on SBS television which is 'satellited' all over Australia? Suddenly the program is cut, to be replaced with the satellite link desperately trying to switch itself to a new working channel.

One night I videotaped a session when the SBS satellite channel was having one of its periodic fits of apoplexy. Then I played it back frame by frame to see what was actually going on. Among other things the link was producing quick flashes of message frames saying something like 'This is an illegal decoder' and then giving a 008 number to ring if you wanted more information. Illegal decoder? Golly — is that an example of satellite reliability?

Yes, satellites are great, repeaters are great. But no, let's not put all our eggs in one basket. We might find our whole communications capability comes crashing down around our ears at the time we need it most! Despite all the technological advances we should never lose sight of the fact that we must always retain the ability to communicate with one another without depending on any outside help at all. ■

THE SERVICEMAN

Protection relays, satellite trackers — and a set that threw itself out of whack

In the September 1990 edition I appealed for contributions from 'non-domestic' servicemen — workers in the industrial or commercial fields. The appeal bore fruit almost before the ink was dry, and the two of the items I have for you this month are the result. The third is from my own bench, with the tale of an ordinary colour TV set with a very strange set of symptoms...

The first of my contributed stories comes from Mr K.V., of Kallangur, Queensland. K.V. works in an industrial situation, and his contribution introduces an immediate conflict of definitions. He writes about a 'protection relay' which turns out to be not an electro-magnetic switch such as we might find in domestic equipment, but the electronic sensing and drive networks that operate a large circuit breaker.

Well, I asked for material from other fields, so I'll just have to live with what I get. I hope you find it as interesting as I did. K.V. writes:

I work in the industrial field, but the principles of fault finding and repair are basically the same as in the domestic field.

One job encountered recently was to repair a protection relay, with two faults in it — one intermittent. The relay had been in service for a number of years before the problem showed itself.

These units are on continuously, monitoring the power flow in a high voltage transmission line. They can make a decision to trip the line in 20 milliseconds in the event of a fault.

The relay contains 20 plug-in cards, with up to 43 transistors on each card. Knowing the operation of the unit, it is relatively easy to locate the faulty card.

The first fault was simply a section that would not work. A quick check over the card with a CRO revealed one input signal disappeared after entering a resistor. Replacing the open circuit resistor put this card back in operation again. (How I wish all jobs were that easy! — Ed.)

The intermittent fault showed itself during this time by another section failing to operate correctly. The power was switched off and the suspect card put on an 'extender' to check its operation. Of course, when the relay was switched back on, it was OK.

This card was the odd one out. All the other cards were neatly made with solder masks over the PC tracks. The boards had been cleaned thoroughly and then varnished. The faulty card was obviously a prototype. It had been hand soldered, with plenty of flux and no solder mask, and then varnished without cleaning.

When first switched on, this card did its job OK. Various signals mixed at the input and produced a 50Hz square wave at T1. But after a time the signal became noisy and gradually dropped in amplitude until it disappeared.

"T1 must be faulty", I thought. But after replacing it, the fault showed up again. To save time, T2, T3 and T4 were also replaced; but again the fault soon reappeared. It appeared as though the collector of T1 was being pulled to the common rail.

Each time I looked at the underside of the board, I thought "What a mess! Flux everywhere under the varnish". I remembered one of the Serviceman's stories about leakage between tracks caused by impurities in the circuit board material. The track from T1 collector to R13 ran parallel with the common rail and seemed to be a likely spot for trouble.

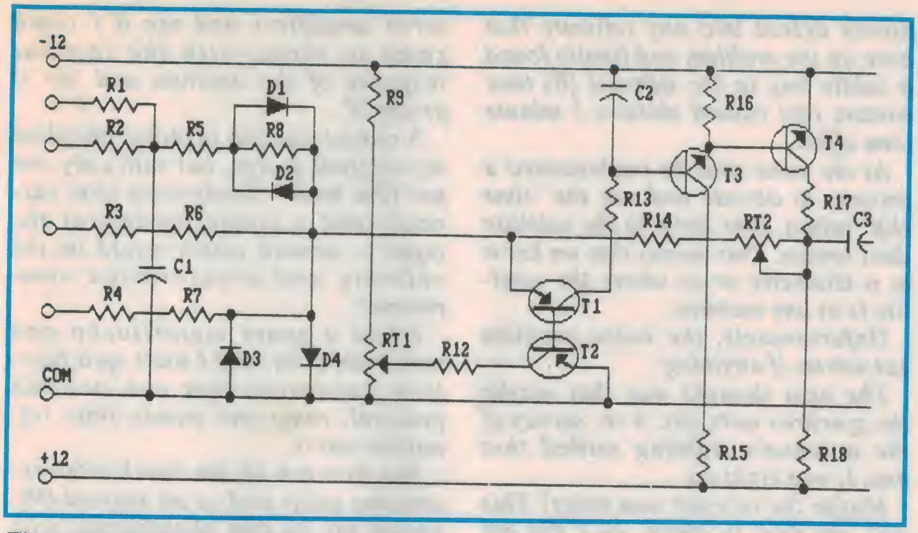
Out came the solvent, toothbrush and scraper! After much scrubbing, the board was eventually cleaned of all traces of flux and varnish and then dried. This time it tested OK, even after a few days of being left switched on. A coat of varnish was applied to it and the relay was returned to service.

I later tried bridging the collector of T1 to the common rail with a 20 megohm resistor. This was enough to stop the relay, so the flux bridge must have been of this order. Such a high order of impedance is unusual in transistor circuitry, but it must be considered in any case of unexplained failure.

It is also advisable to always clean off a circuit board assembly after repair. Metho and a tooth brush kept expressly for this job are quite effective.

Thanks, K.V., that little story shows that production faults are not the sole prerogative of cheap domestic equipment.

I have often knocked dollops of flux and other foreign material off circuit boards, not so much to cure a fault but more to prevent them happening in future. I feel that the track



The schematic diagram for the 'industrial protection relay' sensing circuit, which forms the subject of this month's first contributed story from K.V.

side of a circuit board should consist of copper, solder and varnish. Anything else is foreign matter and should be removed. Besides, a clean board looks better than a messy one!

Satellite tracking

Our next story is rather more involved than K.V.'s. It introduces new terms and concepts that have never been used in these pages before. In fact, it's all about a semi-professional satellite tracking system. It comes from Mr T.B., of Wellington in New Zealand. (For the benefit of non-technical readers, I will include a glossary of terms at the end of the story. The terms to be explained are followed by numbers in brackets.)

T.B. is an officer of the NZ Department of Scientific and Industrial Research (DSIR), the Kiwi equivalent of our CSIRO. Like so many organisations these days, the DSIR is strapped for cash, so when they wanted to do some research into weather forecasting, they looked around for ways to interrogate the weather satellites that pass overhead every day. But they couldn't afford the quarter-million-odd dollars needed to buy a new satellite receiver.

It so happens that T.B. is also one of a group of radio amateurs who had bid for and won an obsolete weather radar antenna, from another Government organisation. Unfortunately, the amateurs couldn't afford the computer and software needed to operate the antenna.

So a deal was reached. The amateurs would provide the antenna and the manpower to install and operate it, while the DSIR would provide the computer and pick up the day-to-day running costs.

(That background material is not part of the story, but was necessary to set the scene for the problems that follow. The full story is quite interesting and T.B. has agreed to tell it on another page, at another time.) He takes up the story:

This tale is about a satellite tracking antenna and a fault in its servo — one that really had me going round in circles.

The antenna in question was a 1960's vintage radar which I came by and modified for tracking weather satellites transmitting on 1700MHz.

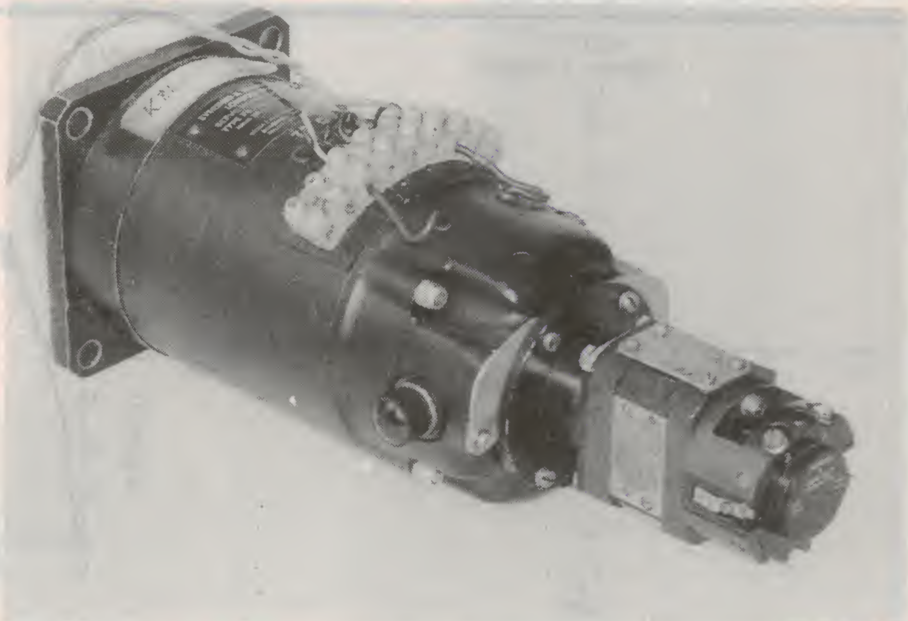
The original elevation (1) and azimuth (2) drives used vacuum tube servo amplifiers (3), powering the split field windings of the motor/tacho (4) units. Naturally I decided this was a bit archaic, so I built solid state amplifiers to replace the original units.

Being a bit shaky on servo theory, I made everything adjustable: velocity and acceleration feedback, gain, motor bias current and DC balance. The control system consists of a VAX computer program that looks every half second at the current elevation and azimuth, via synchro-to-digital converters (5); compares this to the predicted positions, and using a model of the servo response, sends an appropriate analog voltage via D/A's to the servo amplifier inputs, to minimize the pointing error.

Because of all the variables in the amplifier, it was decided to set all the pots to midscale and use a 'demand step' program to measure the servo response.

This resulted in a curve of the style shown in Fig.1. Apart from a rather large deadband in the centre and rather steep response when the motor got going (i.e., not too many D/A bits between 'creep' and 'flat out'), the system worked quite well. And since the data received was of reasonable quality, that's how the system ran for about 18 months.

I always felt that I should revisit the servo amplifier and do it better, as the azimuth channel always rocked back



The servo motor/tacho generator unit from the satellite antenna system discussed in T.B.'s contributed story. The larger main section at left is the motor, while the smaller unit attached to its rear end (right) is the tacho generator.

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and forth a degree or so during a pass, and with a 5° beam width and 2dB link margin, there were occasional noise bursts on the data. But because this was more of an aesthetic than a practical problem, things were let be.

Anyway, after 18 months or so we noticed the signal becoming more noisy, in an erratic and intermittent way. In a system like this the possibilities are:

- Pointing errors due to ephemeris (6) errors or servo response;
- The LNA (7) or other stages of the receiver going noisy;
- Problems in the bit synchroniser; or
- As a remote possibility, problems in the rest of the control or image processing software.

The problem seemed to get worse from the first of January, so the ephemeris error was a logical suspect.

At this point of course you have the classic standoff, between the hardware person (me) and the two software people — Dave who did the antenna control, and Stephen who worries about tracking.

Because of the '1st of January' feature in the problem, and because I could not find any electronic problems — even though the antenna did seem to be rocking a bit more than usual — it was decided that there was an ephemeris problem. So Steven delved into any software that bore on the problem and finally found a subtle bug in the sidereal (8) time routine that caused about a 1 minute time offset.

At the same time he implemented a process to decode and use the 'time slip' values, sent down in the satellite data stream. This means that we know to a kilometre or so where the satellite is at any moment.

Unfortunately, the noise problem got worse, if anything.

The next thought was that maybe the synchros were out. A re- survey of the antenna's sighting settled that one. It was right on.

Maybe the receiver was noisy? This was not easy to check, as I did not have any suitable test gear. 1700MHz signal generators with wideband phase modulation capability are a bit thin on the ground.

I decided to do what I could with an old radiosonde (9) and a calibrated attenuator. From a hilltop at known range, and a value of CW output measured on a spectrum analyser, the beamwidth of the antenna was measured and an estimate of sensitivity calculated.

Unfortunately the measurement errors are very much in the same range as the link margin (2 or 3dB), so this test was inconclusive.

About this stage the noise problem had got to the point where the received data was considered considerably degraded.

I decided to build a new pair of servo amplifiers and see if I could come to terms with the inertial response of the antenna and 'do it properly'.

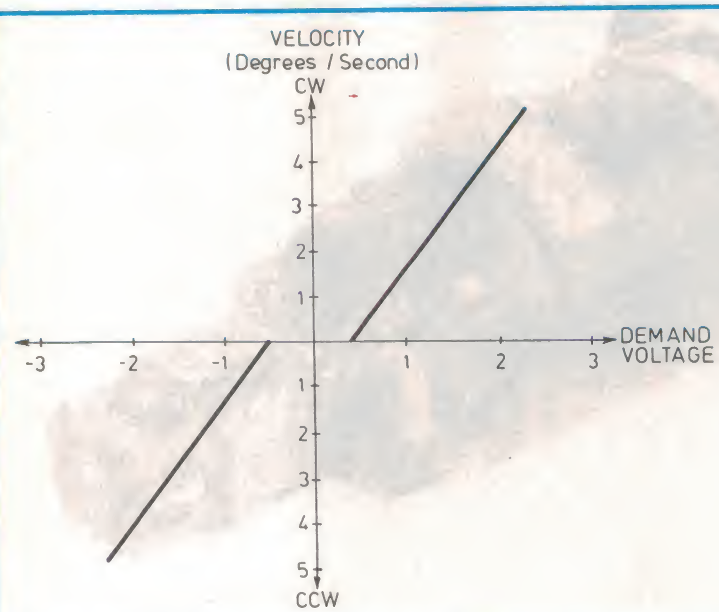
A circuit was put together based on my original design, but with only one pot (the motor steady-state bias current), and a single op-amp at the input — around which would be the velocity and acceleration components.

I had a spare motor/tacho and power supplies, and I built up a function generator that can provide pedestal, ramp and steady state signals to test it.

The first test on the bench after optimising gains and so on seemed OK, except for an odd phenomenon with the output transistors (BUY69C's). If the 180 volt supply for the motor field windings was applied after the +/-12V op-amp power, the standing current increased to about three times its set value. The effect was to make the response of the amplifier 'soggy', as if it had low gain.

All five BUY69C's I had showed this effect. Changing to BU208A's eliminated the effect. Presumably the BUY69A's were leaky; they behaved as if they had a collector/emitter resistor, as the current went up steadily with increasing HT voltage.

Having sorted all this out, the various components around the input stage were adjusted until the motor response (as measured by the tacho voltage output) was a good copy of the input driving function (control



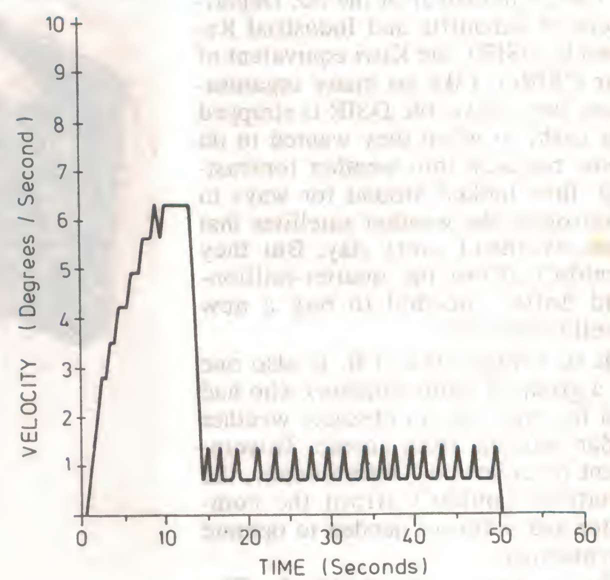
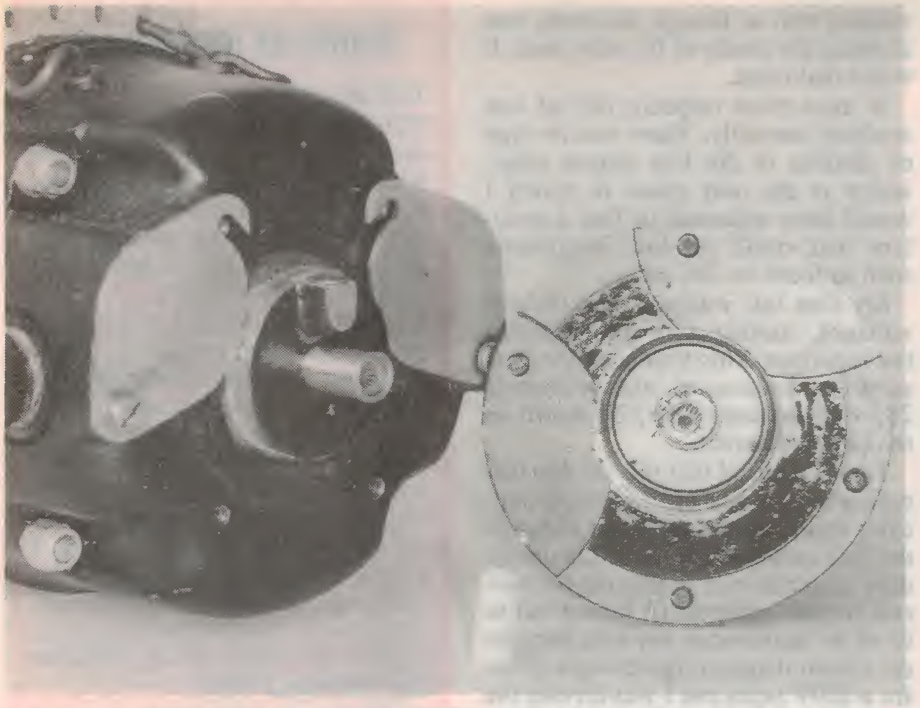


Fig.1 (left): The measured response of the antenna drive system, comparing slewing velocity against demand voltage. Note the central 'dead band'. Fig.2 (right): The measured response as a function of time, for an input azimuth step of 34 degrees.



A close-up of the drive motor and tacho generator when unbolted, showing the method of coupling. A spare plastic insert is shown at lower front.

voltage). Now to try it out on the real antenna.

Disaster - it was worse than the old amplifier!

A plot of the synchro rate against an input step is shown in Fig.2. This kind of response was evident at all values of input step, with very poor control at low values. This is the most important area, because you need to be able to 'creep' a satellite antenna reliably — it spends most of its active time going very slowly.

The maximum azimuth slew rate of 7°/sec occurs very briefly, on passes that go 'right over the top'.

At this point much discussion ensued, about the inertial response of the antenna's mechanical component and how to measure it. A lot of staring at thick books on servo theory only led to the conclusion that we needed numbers that were almost impossible to measure.

The long time constant involved seemed very hard to explain. At this time I tried many variations of velocity and acceleration components, to no avail.

A servo expert's view was 'cut and try, and when it works figure out the theory afterwards'. Of course, with hindsight, the answer to the problem was staring right at us, in Fig.2.

I saw this as a long time constant, combined with a non- linear effect in the amplifier. But while measuring the tacho voltage I noticed it seemed intermittent. Ahah! An intermittent winding or bad brushes. I cleaned up the brushes, but there was no change. So I changed the tacho. The mechanical arrangement of the coupling between the tacho and motor is shown in the accompanying photo.

This was done, but there was still no change. Then the penny (sorry — cent!) finally dropped. I had reused the plastic sleeve that connects the tacho to the motor shaft, and that was the root cause of the problem.

The outer surface had worn to the point that it was only coupling to the motor shaft some of the time. When a step voltage input signal was applied, the motor would run flat out for a second or so until the coupling 'caught', and then the negative feedback from the tacho made the motor slow down. Hence the curve of Fig.2.

Because of the machined surfaces aligning the motor and tacho, you could not feel the tightness or otherwise of the coupling. A small piece of plastic tape around the coupling proved the point. Suddenly we had perfect pictures and zero bit error rate!

I think I would give myself no more than 2 out of 10 for finding this fault. We dived off into many tangents and tidied up some loose ends along the way, but what a trail to find a tiny piece of worn plastic!

Well, T.B., I don't know about the 2 out of 10 for fault finding, but your story is worth 10 out of 10 for interest.

Like many lay-persons, I imagined that a satellite antenna was pointed in the right direction to acquire the bird, then moved to maintain the best signal strength as the satellite passed across the sky. I didn't think that it had to be constantly repositioned according to some pre-calculated table. We live and learn, don't we?

As for the fault itself, just how many times have these pages revealed a purely mechanical problem as the reason for a malfunction in complex electronic equipment. You can think of volume controls, switches, mechanical linkages of one kind or another, even the ubiquitous dry joint. All are mechanical in one way or another, and all of them can give us headaches at least, and ulcers at worst.

Thanks, T.B., I'm glad that your ulcer can now have a rest for a while. And now, as promised, here is the glossary of terms used by T.B. in his story:

(1) Elevation: the angle of an object, above the horizon, as seen by the observer.

(2) Azimuth: the direction of an object from the observer, in a horizontal plane.

(3) Servo: a system used to accurately control a mechanical item — i.e., a motor, in both direction and speed.

(4) Tacho: a device attached to a motor shaft to relay details of its speed to a controlling mechanism.

(5) Synchro: a device attached to a piece of equipment to relay details of its position to a controlling servo system.

(6) Ephemeris: A table or list of figures representing the position of a satellite (or heavenly body) at any time or date.

(7) LNA: Low noise amplifier — the first stage in a satellite receiver.

(8) Sidereal (Time): The time at which a star passes over a particular meridian. A sidereal day is about 4 minutes longer than a solar day.

(9) Radiosonde: A small balloon-borne radio transmitter that can send high altitude weather details back to the ground.

Blame the cleaner?

Now back to my own bench, and while we are on the subject of mechanical rather than electronic

problems, I'd like to tell the story of one set that came into the workshop recently. It was a National TC2202 colour TV, fitted with an M7 chassis.

The customer claimed that the set had been working OK until his wife was poking around near it with the vacuum cleaner. Then 'all the colour went' and the picture shifted to one side.

Now I've heard of cleaners destroying the purity of the picture, but that usually results in wrong colour — not NO colour. Then again, there has never been any suggestion that the cleaner could shift the picture off to one side.

Just as he'd described

When I got the set on the bench, it was almost exactly as the customer said. The picture was a purplish monochrome, with a green patch in the top right corner.

And the picture had really shifted. There was a 75mm band of black down the right hand side of the screen, and both both top and bottom corners of the left hand side were masked out, as though the beam was clipping the inside of the tube neck. It was a real mess.

In most other respects, the set was working normally. There was no sign of distress in the line output stage, which is the only place in which I would have expected to find a problem that could produce symptoms such as those on this set.

My first test was to check the rail voltages, starting with the output of the regulator. This produced the first surprise, because it was delivering 280 volts instead of the 230 shown on the circuit diagram.

Then I realised that this set has two regulators — one on the bridge rectifier board, and another just ahead of the line output stage. And this secondary regulator was producing the correct output voltages. (It turned out to be of no importance anyway, because the circuit diagram figures were given for a 220V input and I was driving the set with 240V. Thus all the input voltages had to be high and the second regulator was doing its job properly.)

To shorten a long story, I spent an hour trying to find out why the picture was shifted to the left. Only unwanted DC in the yoke could cause the fault, but there was no sign of any such current. So if it wasn't DC, it had to be a permanent magnet effect — and the only magnets around about were the shift magnets in the static convergence assembly.

The penny dropped...

And this put me on the right trail. All four static magnets had been twisted 180° out of position. In just a few moments I had perfect convergence at centre screen, and the picture had come across to eliminate the black band on the right.

Next I tried the dynamic convergence controls, and found each of these to be a long way out of their proper position.

Then I tackled the purity controls, and this led to quite a bit of frustration because I couldn't get a green image to work on. (In these in-line tubes the green gun is the centre one and is used for purity adjustments.)

I checked the screen voltages and found them to be all within reasonable levels. Certainly not so far out as to cause the complete loss of green.

So I decided to check the voltages on the output transistor collectors. I expected to find a wrong voltage on the green collector, but nothing like the fault that I did uncover.

As I put the meter probe on the collector pin, something moved and there was a 'tinkle' on the main chassis, underneath the picture tube base board. The tinkle turned out to be caused by the output transistor landing on the chassis. It had been unsoldered for some reason, and had never been resoldered. It was loose in the board, on all three pins!

Resoldering the transistor restored a green image and the purity adjustment was soon completed. Then after a quick once- over the focus and vertical adjustments, the set was delivering a picture as good as any I've seen on a set of that age.

When the customer called to pick up the set, he told me that he had only recently bought it, second hand, from a dealer. He seemed certain that the picture had been good to start with, but I wonder.

I could accept one control being out of position, but not a dozen or more. And transistors do NOT unsolder themselves. Somebody is being liberal with the truth, and it isn't me.

But should I worry? I was paid to put the set right and if that only meant restoring maladjustments put there by somebody else, I've still done my job. But see what I mean about mechanical problems? There wasn't a single 'electrical' fault in the whole job!

Cheers for now. I'll be back with more next month. ■

Fault of the Month

Toshiba C412

SYMPTOM: No colour. This was not a dry joint on one of the double-sided board pin-throughs, so common on this model. Chroma and all the relevant pulses were going into the chroma board, but nothing was coming out.

CURE: The chroma processing chip, a TA7148P, was faulty. These chips are no longer available from suppliers but they were also used in early Sanyo and Princess sets, so junked versions of these brands could keep an old Toshiba working.

This information is supplied by courtesy of the Tasmanian Branch of The Electronic Technicians' Institute of Australia (TETIA). Contributions should be sent to J. Lawler, 16 Adina Street, Geilston Bay, Tasmania 7015.

The ratio detector, phases & vectors

The ratio detector is an excellent FM demodulator. It extracts the audio signal from the frequency modulated carrier but ignores any unwanted noise, interference or AM which may be adulterating the signal. But to see how the ratio detector works we first must investigate waveforms, phase angles and vector diagrams...

by BRYAN MAHER

At the FM transmitter the audio signal is impressed upon the RF carrier wave by varying the carrier frequency proportionally to the audio amplitude. The transmitted signal has constant overall amplitude.

Unfortunately this nice clean transmitted signal may be adulterated along the way to your receiver by radio frequency interference (RFI) caused by lightning, storms, electric trains, trams, arcs or thyristors. As well the receiver front end RF amplifiers and mixers will generate some electrical noise signals of their own.

All these interferences tend to change the amplitude of the received signal, but have no effect on its frequency.

Each FM receiver must contain an FM demodulator stage to extract the audio from the received RF signal, aiming to reproduce the music and speech by responding only to the RF frequency variations. It should ignore completely any unwanted amplitude variations in the RF signal.

Ratio detector

The ratio detector, Fig.1 is one type of FM demodulator which achieves this aim very well. This circuit was a favourite for many years in TV receiver sound sections and FM radios.

Exhibiting quite good linearity in its response to frequency modulation, the ratio detector in ideal form has no response at all to RFI, noise or AM.

This last point is important in the sound sections of TV receivers, where the picture signal is in the form of amplitude modulation. Misadjustments or very low received signal level can cause AM picture, sync or sweep signals to appear in the sound IF signal.

This factor is accentuated in fringe area TV reception, where the weak FM sound carrier competes against the TV receiver's own powerful line and frame signals. Wonderful! Now let's see how this clever little ratio detector, Fig.1, works.

In either an FM receiver or TV set sound section, Q1 is the final intermediate frequency amplifier whose output signal is V1. L2C2 is a tuned tank circuit, with L2 centre tapped at H. We denote the top and bottom halves of L2 as L2A and L2B respectively. L1 is the primary winding of this little IF transformer, the whole of L2 forming the secondary.

The IF signal V1 is magnetically coupled by L1 into the tank L2C2. As L2C2 is accurately tuned to the IF centre frequency fc, circulating current i2 flows continuously around the path L2A, L2B and C2.

As we recall from chapter 3 of this series (*EA* Aug.88, p102) circulating current i2 is always at the tuned frequency fc. That last observation is vital to understanding the circuit's operation.

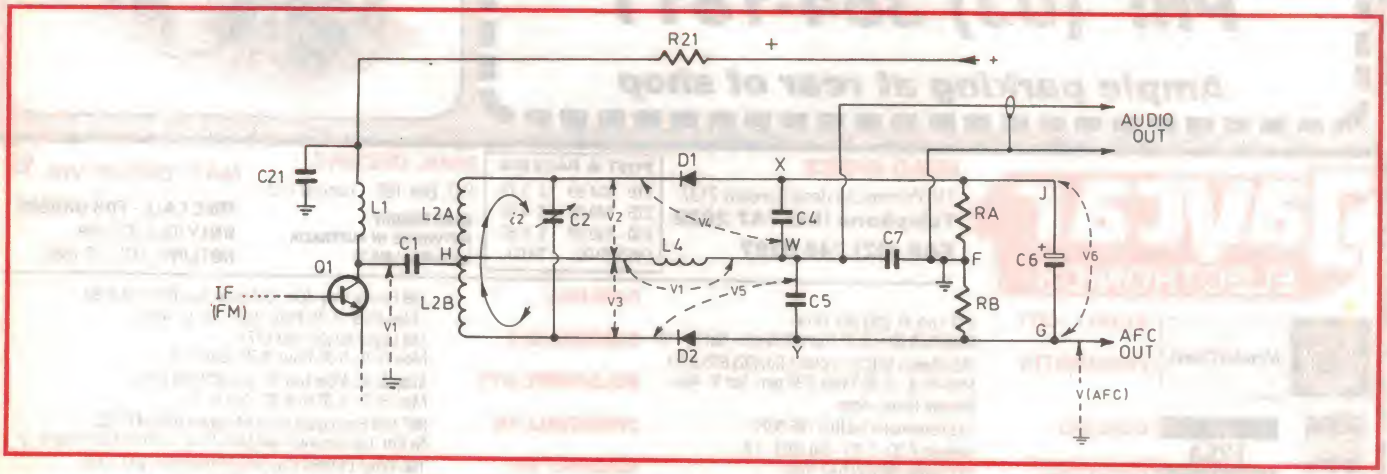


Fig.1: The ratio detector, an FM demodulator which was used for many years in FM receivers and TV sound circuits.

Vectors

To see how the ratio detector works, we must first see how RF and IF signals can be described by vector diagrams.

We can represent any AC voltage or current by just drawing a straight line on paper, calling that line a vector. Sometimes it's called a phasor. (No, no — not the kind used by the *Star Trek* crew!)

How can a straight line denote RF voltage? Does this description make sense? Yes it does, for AC sine waves only, at any frequency, low or high, from mains 50Hz to UHF. But first some background.

Let's reiterate some facts we have seen before in this series and elsewhere, talking only about sine waves. We know that, at least for low frequencies, AC voltages can be generated by rotating machines.

A basic single turn, two-pole AC generator is shown in Fig.2(a). N and S are the permanent magnet poles which set up a magnetic field. Within this field the turn of wire K rotates, generating AC voltage which varies in instantaneous value as the turn goes around and around.

Figs.2(b) and 2(c) are end-on views of Fig.2(a). The generated voltage has peak value when the turn is moving across the middle of the magnet pole face, at S in Fig.2(b). This is because at that moment the turn K is moving at right angles to the magnetic field direction, and hence at the highest rate relative to the field flux.

After rotating another 90° to W in Fig.2(c), the turn of wire is moving in the same direction as the magnetic field so at that instant no voltage is generated.

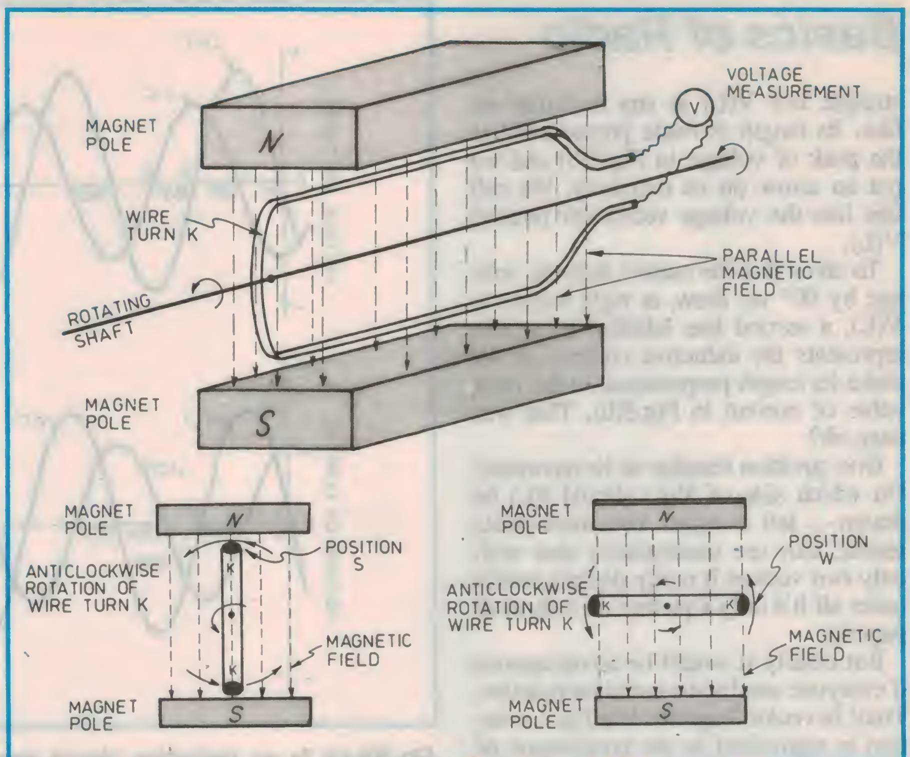


Fig.2: At top is a basic one-turn generator, which can generate low frequency AC whose instantaneous value depends on the angle of the coil with respect to the magnetic field. The two lower diagrams show the coil positions corresponding to the output waveform's peak (left) and zero (right) voltage points.

Time and angle

At some constant rotational speed, obviously angle of rotation and time from the start really mean the same thing.

So Fig.3(a), showing the rise and fall of voltage V during rotation, has its baseline calibrated in both angle and time. The vertical scale is in voltage or current. These drawings are the familiar sine curves.

If a resistor is connected to this toy generator, sinewave current i(R) flows in the resistor as in Fig.3(a). The current wave reaches its maximum value at the same time as does the voltage wave. We say that in a resistive circuit the current and voltage are 'in phase'. That expression means 'reaching peak value at the same time'. (The word phase originally meant an increment of time).

Now, instead, if we connect an *inductive* circuit to our baby generator, the current i(L) cannot rise as fast as the voltage, as shown in Fig.3(b). We find that the voltage has always gone a whole 90° beyond the maximum voltage position S, all the way down to W, before the slowly rising current reaches its maximum.

We then have the strange situation that at time (or angle) W, the current has reached maximum when the voltage has fallen to zero value. As time (and angle through which the rotor K has turned) increases, the voltage and current waveforms continually rise and fall sinusoidally (i.e., in sinewave form), but the current is always 90° behind the voltage. We say that:

In purely inductive circuits, the current LAGS the voltage by 90 degrees.

Vector diagram

That was a piece of cake, wasn't it? Now we will make it easier still! As these are sine waves, we know their shape. All that needs to be said is the maximum value of voltage and current, and the relative angle between them!

Thus Fig.4(b) gives us as much information as Fig.3(b). Wow — How simple can you get! In Fig.4(b), from an origin or starting point O we draw the first

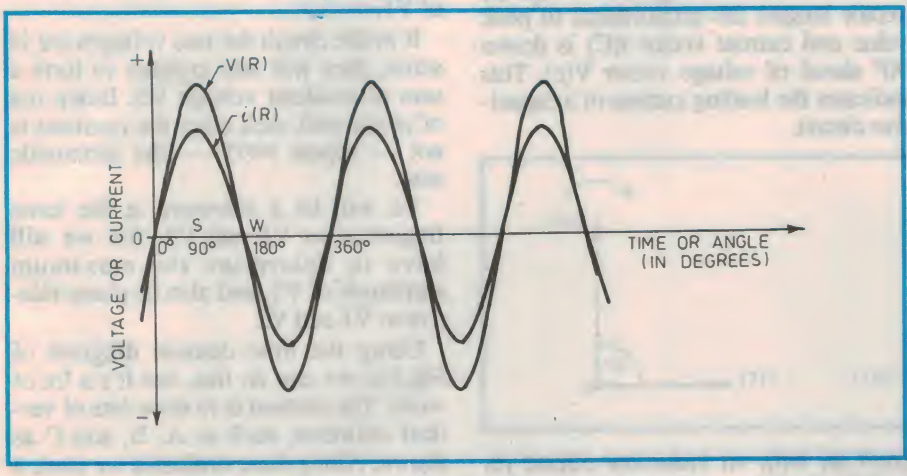


Fig.3(a): In a resistive circuit, the voltage and current waveforms are in phase.

straight line V(L) in any direction we like. Its length is made proportional to the peak of voltage in Fig.3(b) and we put an arrow on its extremity. We call this line the voltage vector (or phasor) V(L).

To show that the current lags the voltage by 90° we draw, at right angles to V(L), a second line labelled i(L). This represents the inductive current, so we make its length proportional to the peak value of current in Fig.3(b). That was easy, eh?

One question remains to be answered. On which side of V(L) should i(L) be drawn — left or right? You, most astute reader, can see immediately that with only two vectors it really doesn't matter (after all it's only a picture on a sheet of paper!).

But clearly it would be advantageous if everyone used some common practice. True! In vector diagrams like Fig.4, rotation is equivalent to the progression of time and angle in Figs.2 and 3. The universal convention is to assume that time and angle progress in *anticlockwise* direction, indicated by the arc drawn above Fig.4(b).

As inductive current lags circuit voltage, we therefore draw current vector i(L) in Fig.4(b) on the right side of the voltage vector V(L).

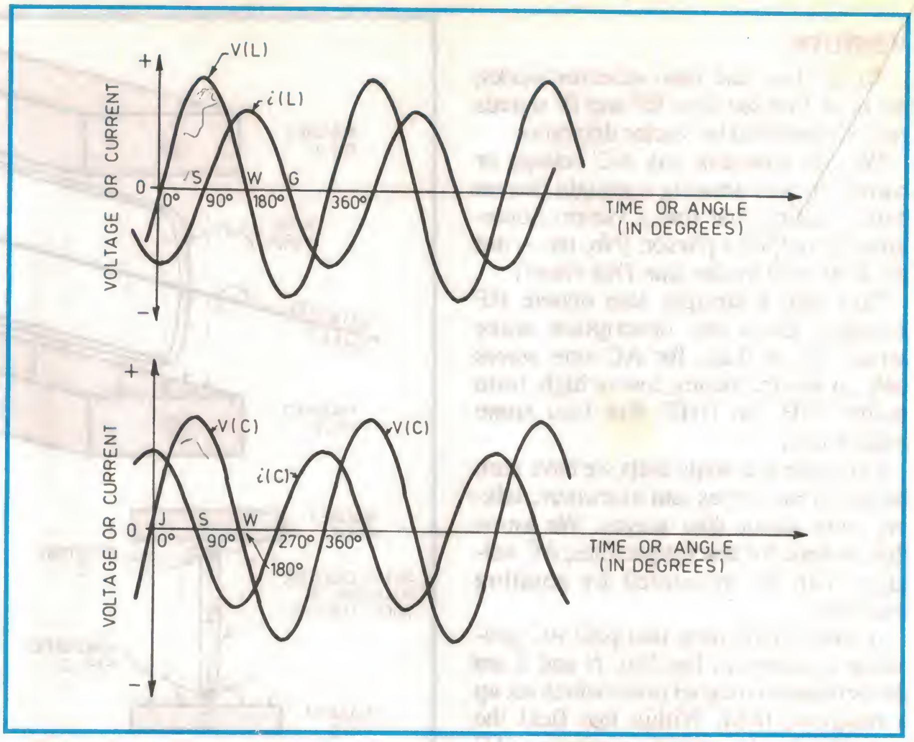


Fig.3(b,c): In an inductive circuit (top), the current lags behind the voltage, whereas in a capacitive circuit (above) the current leads the voltage.

Rotating diagram

We imagine that as time and angle progress, the whole diagram continuously rotates anticlockwise on the paper, around the origin O. Now if we sit on the sheet of paper and watch, the voltage vector will go past us before the current vector does, indicating that current lags the voltage in this circuit. (Like slow horses you back on Saturday).

Now it is obvious what a vector diagram to represent Fig.3(a) would look like. As Fig.3(a) depicts a purely resistive circuit, here voltage and current rise and fall in step, ie in phase with each other. No angle difference at all. Therefore Fig.3(a) is described by vector diagram Fig.4(a) in which the voltage and current vectors are drawn in the same direction.

In a capacitor, the current depends on the rate of change of voltage. A sinewave voltage changes fastest while rising through zero value, as at J in Fig.3(c). Here the voltage wave V(C) has greatest slope, therefore here the current i(C) has maximum value. Thus capacitive current is always 90° ahead of the voltage which causes it. We say that:

In a purely capacitive circuit, current leads voltage by 90 degrees.

It's easy to see how to draw a vector diagram to represent voltage and current in a capacitive circuit, giving the same information as does Fig.3(c). In Fig.4(c) vector lengths are proportional to peak value and current vector i(C) is drawn 90° ahead of voltage vector V(c). This indicates the leading current of a capacitive circuit.

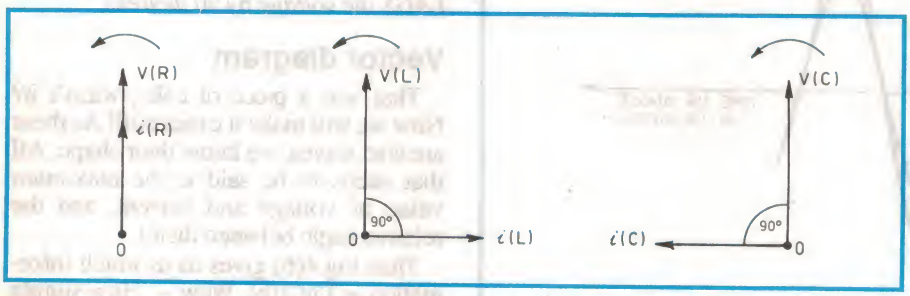


Fig.4: Vector diagrams for a resistive circuit (a, left), an inductive circuit (b, centre), and a capacitive circuit (c, right). Visualise each as rotating anticlockwise.

Multiple sources

How would we draw diagrams for a circuit containing multiple voltage sources? For example if in a system two separate sources each contribute different voltages V1 and V2, as in Fig.5(a), where (a) V1 is not equal to V2; (b) both are sinewaves; (c) they're of equal frequency; and (d) V1 and V2 are not in phase with each other.

For example say V1 leads V2 by 60°. In the time (or angle) domain diagram, Fig.5(a), we draw sinewaves V1 and V2, each to scale proportional to their respective amplitudes. As both sinewaves are of same frequency but with a 60É lead between V1 and V2, we just begin the sketch of V2 60° to the right of the start of V1.

If in the circuit the two voltages are in series, they will add together to form a sum or resultant voltage VS. Being out of phase with each other the resultant is not — repeat NOT — the arithmetic sum.

VS will be a sinewave at the same frequency as V1 and V2. But we still have to determine the maximum amplitude of VS, and also its phase relative to V1 and V2.

Using the time domain diagram of Fig.5(a) we can do that, but it's a lot of work! The method is to draw lots of vertical ordinates, such as A, B, and C as shown. Along these ordinates we mark a point A1 where sinewave V1 intercepts

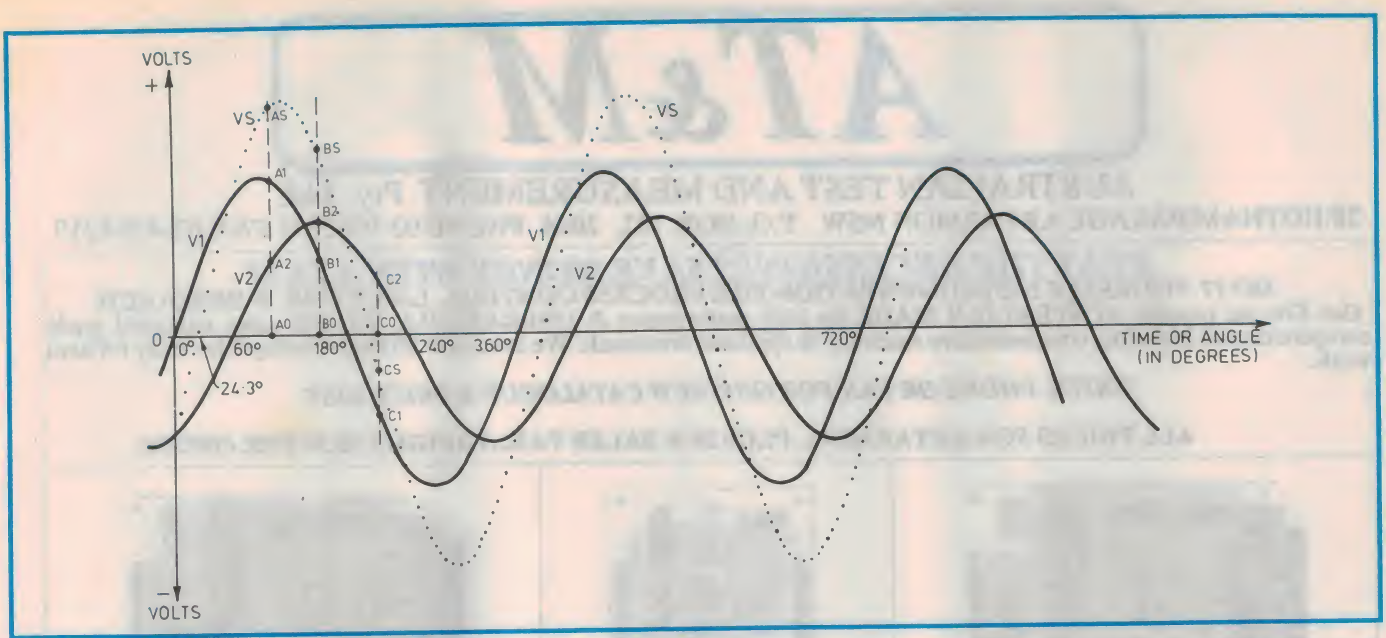


Fig.5(a): A time domain diagram showing two voltages V1 and V2, with the latter delayed by 60 degrees, and their sum voltage Vs. Each point on the Vs waveform can be plotted laboriously, as in examples A, B and C.

the ordinate. Similarly we mark the point A2 where V2 intercepts. Then add the lengths (AO — A1) and (AO — A2) together, giving a sum we call AS. Then starting at AO mark this length AS along the ordinate.

All that work gives us the location AS, which is a single point on the voltage sinewave VS, the sum of V1 and V2.

By repeating the process we add (BO — B1) and (BO — B2) together to obtain BS, another point on the sum voltage waveform VS. Repeat again using CO, C1, C2 to get CS. Continue this process for more and more ordinates, *ad nauseum*.

If we don't go stark raving mad first, we will have enough plotted points of voltage waveform VS. Then joining

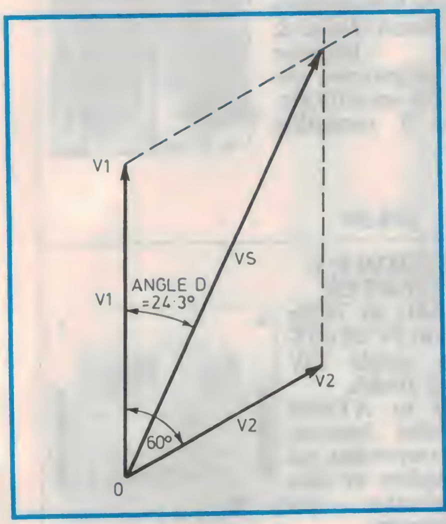


Fig.5(b): On the other hand, vector addition gives the answer much faster.

them up we have the final waveform result. This will show that:

(1) VS is indeed a sine waveform voltage
(2) V1, V2 and VS all have the same frequency
(3) VS is not in phase with either V1 or V2
(4) The amplitude of VS is given by its peak value in Fig.5(a)
(5) The phase relation of VS, relative to V1 and V2, can also be found from Fig.5(a).

Just look at where each crosses the baseline of time and angle. Of the above five results, the first three could have been shown by elementary trigonometry. So what did all that excruciating process achieve? All that construction of VS in Fig.5(a)? It simply gave the amplitude and phase relation for VS!

There must be an easier way, I hear you say! True. You could (a) buy an expensive computer and software to do it for you; or (b) do it yourself, in two minutes at no cost, simply by drawing one little picture like Fig.5(b).

Now we see the true value of vector diagrams! They greatly simplify our understanding of how circuits operate. And what are the conditions? Simple vector diagrams are valid provided:

(1) All voltages are sinewave
(2) All are at the same frequency
(3) All components are linear
(4) Currents are sinewave also

Actually if the first three of the above are true, then the fourth must follow.

Subtraction of AC voltages can also be done using vector diagrams. That's not surprising as (A-B) simply means (A+(-B)). We know that if vector B represents a voltage, the (-B) means vector B rotated 180°. (Remember sinewaves reverse polarity every 180°).

Multiplication?

What about multiplication? Sorry, multiplication of vectors, though possible, does not yield a vector, but gives a scalar (i.e., an ordinary number). E.g., for vector voltage V, the product V.V indicates power, which is not a vector.

The addition of three equal or unequal AC voltages, all at different phase angles, is straightforward. To find (V1+V2+V3) we use vector addition to first obtain (V1+V2). Then we vectorially add that result to V3 to give the final vector sum. Simple!

By repeating this recursive process any number of vector voltages may be added.

Back to the detector

Now after all that groundwork, we are at last ready to proceed with the analysis of the ratio detector FM demodulator, in Fig.1.

But in case you're flaked out and think that's enough for one month, OK — take a break; we will continue the analysis of Fig.1 next time.

Readers overcome with frenetic zeal and frantic enthusiasm may while away the time by adding any number of voltages at any old phase angles. You could construct your own equivalents of Figs.5(a) and 5(b) if you like — a good cure for insomnia!

'Bye until next time. ■

AT&M

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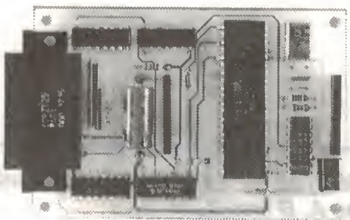

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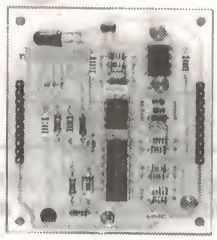

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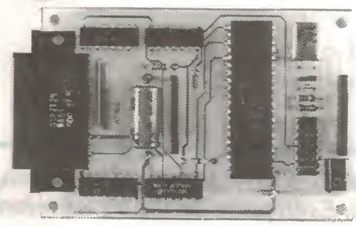

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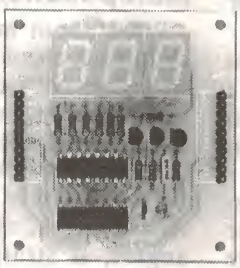

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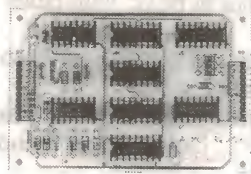

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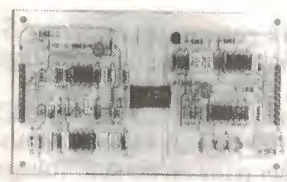

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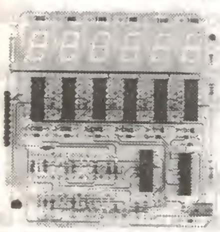

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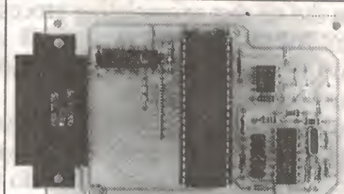

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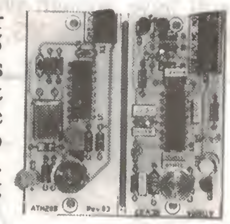

ATM20 $48.50

PRECISION V/F CONVERTER

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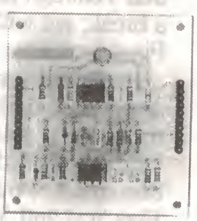

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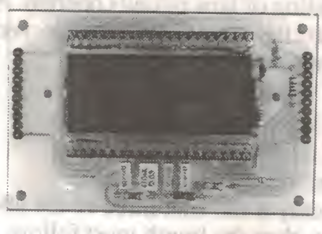

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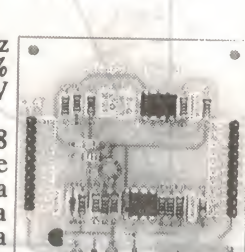


ATM09 $35.50

Circuit & Design Ideas

Interesting circuit ideas from readers and technical literature. While this material has been checked as far as possible for feasibility, the circuits have not been built and tested by us. We therefore cannot accept responsibility, enter into correspondence or provide further information.

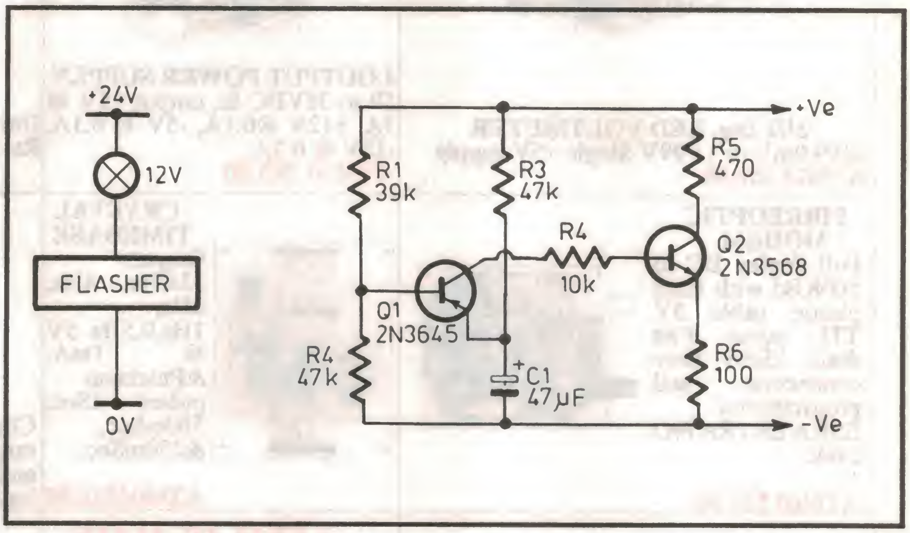
In-line flasher

Most lamp flasher circuits require a supply for the electronics, as distinct from the lamp supply. As a result they are usually three or four-wire devices. This flasher is designed to be simply connected in series with the lamp, and requires no separate supply.

The main disadvantage of this approach is that the lamp has to be designed to operate on a lower voltage than the supply, to get full brightness. The circuit shown was designed to flash an alarm light and sound a Sonalert in a 24V circuit, and accordingly a 12V lamp was used.

However it is easy to adapt the circuit to other voltage; I have built a version which operates from 6V and uses a 4.8V lamp.

The operation is as follows. On switch-on of the supply, C1 charges via R3 until the emitter voltage of Q1 is high enough for it to turn on. C1 then discharges into the base of Q2 via R4, turning it on and passing enough current to light the lamp. When the voltage on C1 drops below the turn-on level for Q1, this transistor turns off and with it Q2. The cycle then repeats.



The flashing frequency is controlled mainly by R3 and C1, with R4 controlling the mark-space or 'on-off' ratio. Resistors R5 and R6 determine the lamp current in the 'on' state, with R6 also having an effect on the on-off ratio.

Philip Andrews,
Hawthorn, SA.

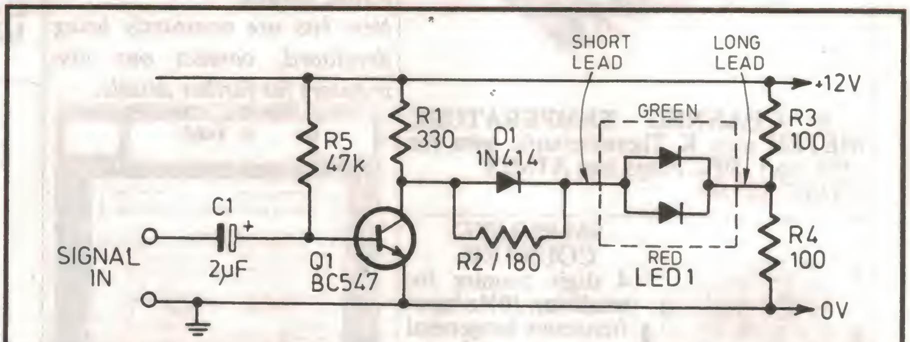
$35

LED signal indicator

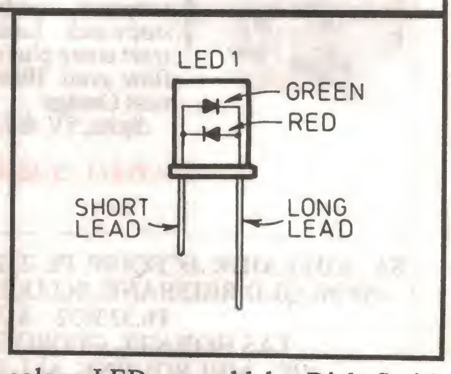
I designed this circuit to monitor the output of each channel of a mixing desk. It is a simple form of LED level indicator, which gives an indication of not only whether or not an input signal is present, but also broadly how it compares with those from other channels. The interesting feature is that it uses only a single LED — of the dual red/green type. This is normally green, but goes through shades of yellow and orange to red, as the input level increases.

This is achieved as follows. When there is no input signal, Q1 is off and current flows through R1, D1, LED1 (lighting it green) and to the negative rail via R4. When an input signal is present, Q1 is switched on during positive half cycles and current flows through R3, LED1 (lighting it red), R2 and down to the negative rail via Q1. This process switches the green LED inside LED1 off when the red LED is conducting, and vice-versa.

There is always a small amount of green glow present even at high signal levels, because the claimping action of C1, R5 and the base emitter junction of Q1 will always result in the transitor dropping out of conduction for a short period during each cycle, at the negative peaks. However by careful choice of component values I have achieved an attractive range of colours.

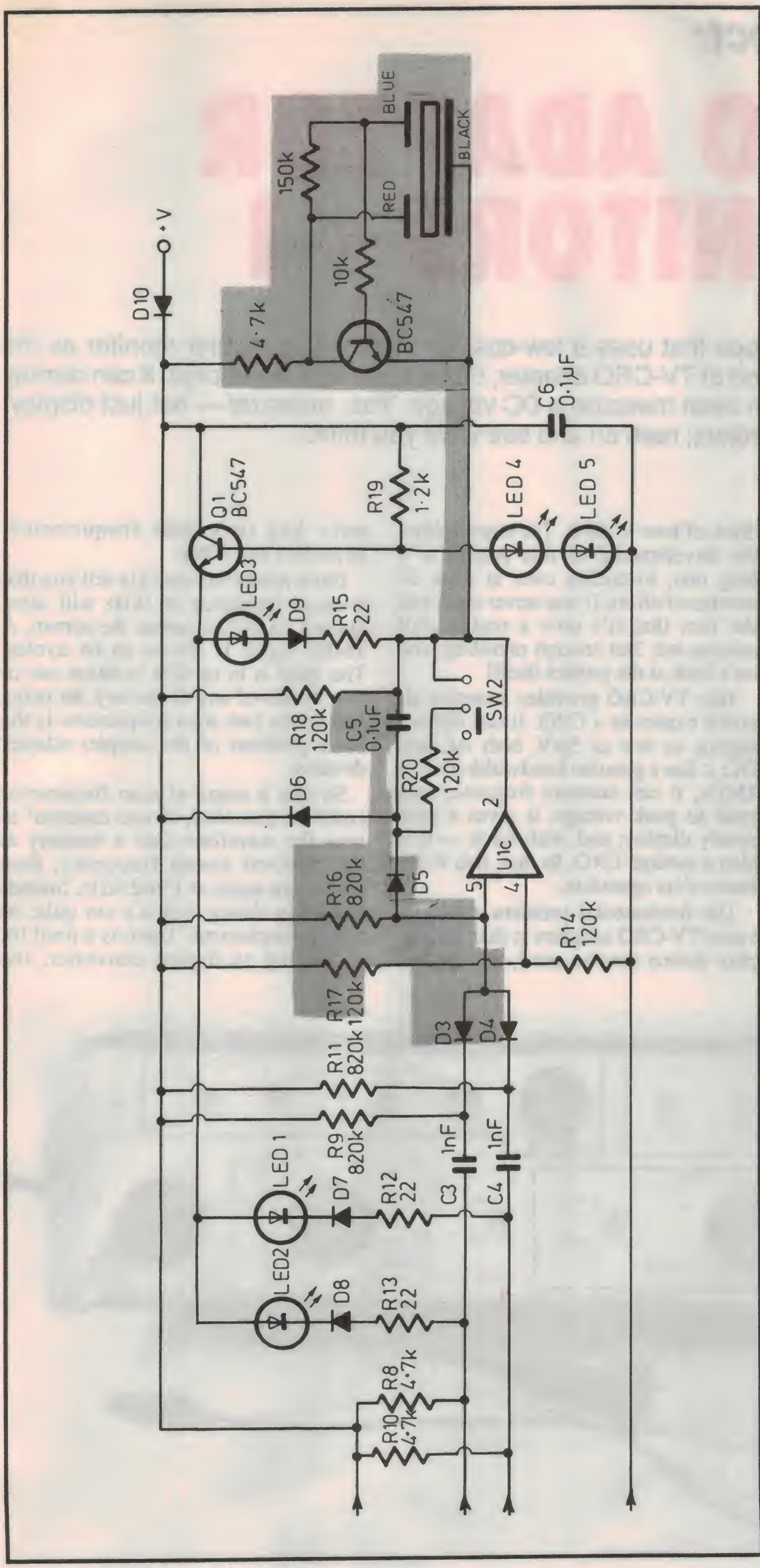


D1 and R2 allow adjustment of the voltage level at which the transition between green and red takes place. The value of R5 may also be adjusted to set the volume level at which the display works most effectively. For use with low signal levels the circuit may need to be provided with a pre-amp stage. LED1 is a two-lead rectangular dual-colour LED, as sold by Dick Smith Electronics for 75 cents.



Julian Phillips,
Temuka, NZ.

$40



Mods to August 1990 logic probe

After building up my kit for the DSE logic probe, as described in the August 1990 EA, I decided to make some changes.

In use, a pulse was only indicated when the input went from a high to a low to its complement, or to off. No pulse indication was given when there was a transition from an off state to a high or low.

I also felt that there was a need for an audible indication of a state change, and preferably to indicate a good connection to the circuit under test.

The modifications shown here permit the probe to give both a 'pulse' indication and an audible indication whenever an indicating LED goes *on*, in contrast with the original design in which the pulse indication occurred when a LED was extinguished.

The audio indicator chosen was a piezo unit (PKM11-6A0), in a 30mm plastic housing with two 'wings'.

These needed 'pruning', and some plastic and part of the metal diaphragm removed from the opposite sides, reducing the dimensions down to 20mm so that it fits inside the probe housing.

The main point to note is that the piezo unit's crystal element must not be twisted or deformed, if it is still to operate correctly. The only other challenge is to fit the additional transistor and other parts indicated.

Briefly, the main change necessary involves reversing D3 and D4, interchanging R16 and R17, then cutting the PC track to isolate R17 (now 120k).

Then a hole is drilled to allow connection of the now-lifted cathode of D5 to the track connecting the anode of D6, C5 (now 0.1uF) and R20.

Track cuts are also required to isolate pin 5 of U1 and between the junction of D3, D4, D5 and R14.

Then all that is needed are three jumpers to connect up the separated portions of the circuitry.

Obviously these mods require some familiarity with electronics, but I found them to be well worth the trouble, making this unit a much more functional tool.

The next improvement I'd like to see is a high or low-pitched audible indication of high and low logic levels — but I'll leave that step to another experimenter.

M.R.McGregor,
Dunedin,NZ.

$40

Construction Project:

NEW CRO ADAPTOR FOR MONITORS - 1

Imagine a fully featured oscilloscope that uses a low-cost conventional computer monitor as the display. This is not your average sort of TV-CRO adapter, this is a whole new concept. It can display waveforms of over 1MHz, and can even measure a DC voltage. Yes, *measure* — not just display. We think this is a really exciting project; read on and see what you think...

by PETER PHILLIPS

I was prompted to develop this project in response to a number of reader requests concerning the TV-CRO adapter published in May 1980. This simple project was obviously still popular, despite its shortcomings, and my first reaction was to examine it with a view to possibly improving it. But the more I looked and thought about it, the more I realised that its very simplicity was the basic problem. It's a case of you 'gets what you pays for'.

This is not a criticism of the project, as quite a number have been built. However, it was never a replacement for a conventional CRO, and that is the goal I sought.

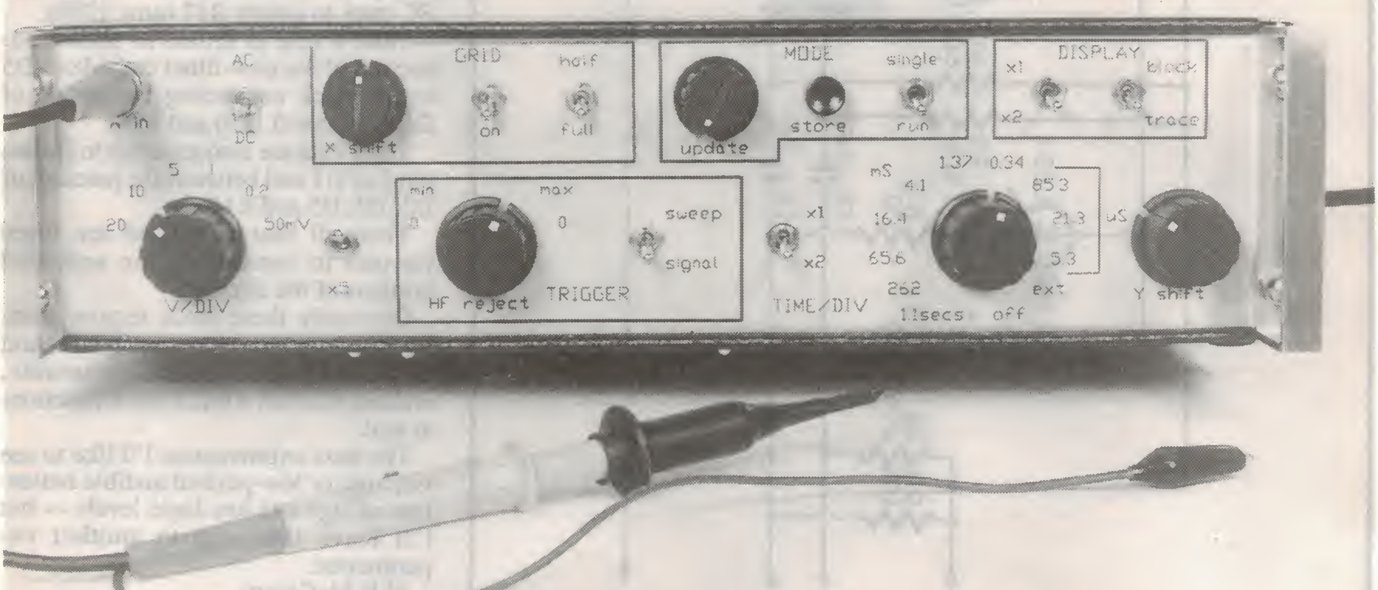
So armed with the idea, I had to think of how to do it. The story behind the development of this project is a long one, extending over at least 20 months of effort. It was never easy, and the fact that it's now a reality still amazes me. But enough rambling, and let's look at the project itself!

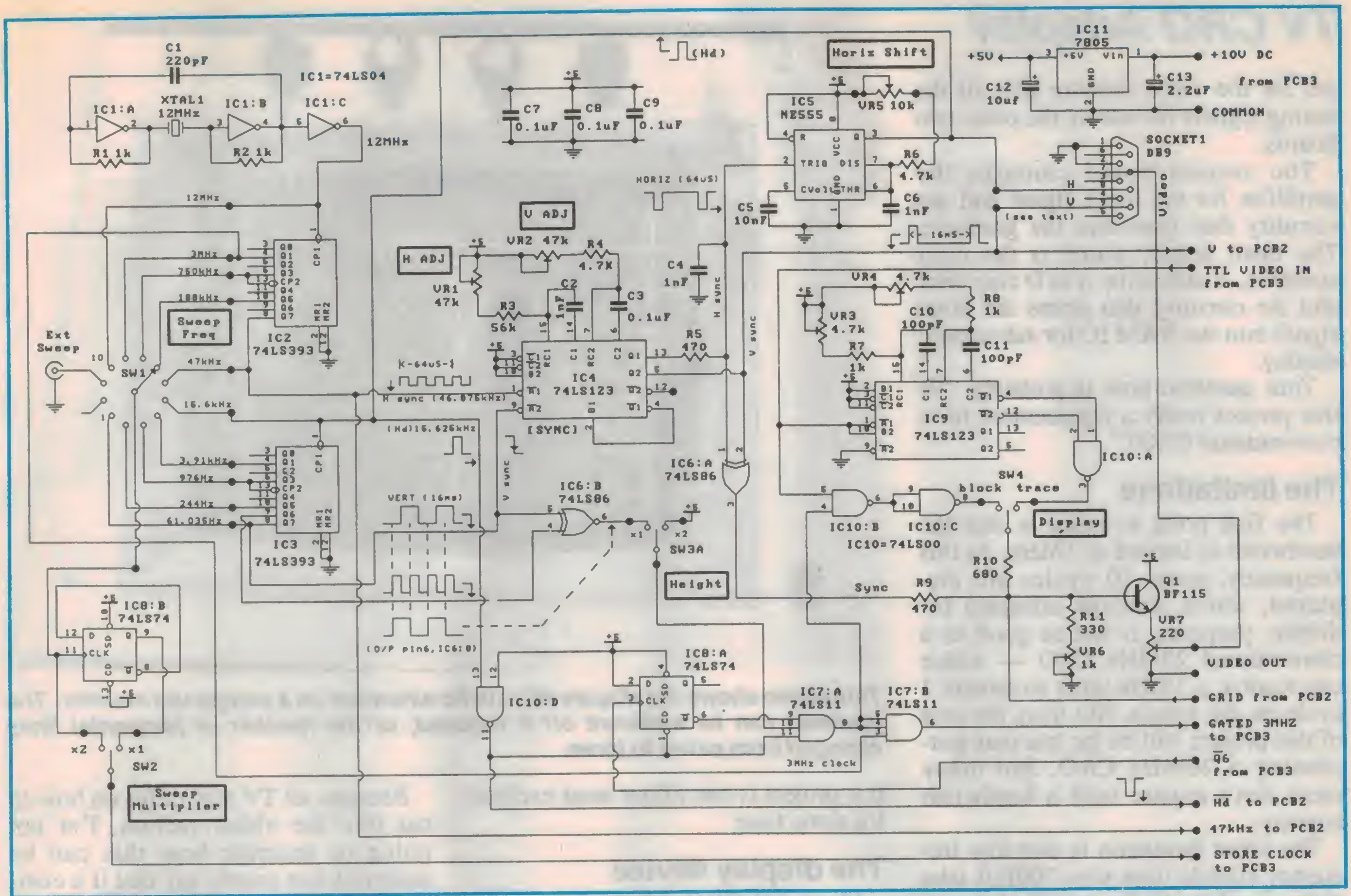
This TV-CRO provides virtually all you'd expect in a CRO. It can display signals as low as 5mV, both AC and DC; it has a genuine bandwidth of over 1MHz, it can measure frequency and peak to peak voltage; it gives a rock steady display; and, wait for it — it is also a storage CRO. In fact, this is the basis of its operation.

The fundamental problem with previous TV-CRO adapters is that the display device they've used, the TV set, only has two scan frequencies: 15,625Hz and 50Hz.

Basic maths will quickly tell you that a signal frequency of 1kHz will show around 15 cycles across the screen. A 1MHz signal is shown as 64 cycles! The ideal is to be able to show one or two cycles of any frequency, so being limited by two scan frequencies is the basic problem of the simpler adapter devices.

So that a range of scan frequencies could be provided, it was essential to scan the waveform into a memory at the selected sweep frequency, then read it out again at 15.625kHz. Sounds simple in theory, but it's not quite so easy to implement. There is a need for an analog to digital converter, the





The circuit for PCB 1. The 23MHz output from IC1c is divided by IC2 and 3 to give a range of sweep frequencies for storing the input signal. The horizontal and vertical sync pulses are produced by IC4, combined by IC6a and then fed to the video output stage of Q1. The output from the 2K memory IC on PCB 3 is converted to give a trace on the screen by IC9 and various timing signals are produced by IC7a and b, IC8a and IC10d.

memory itself, all the logic to drive it as well as circuitry to make the whole thing capable of measuring rather than simply displaying a signal.

So to say this project is simple would be untrue, as it isn't. Why else did it take over 20 months to develop? However to make it seem simple, we are presenting it over three issues. There are three PCBs associated with the circuit, and each one is self standing.

This way you can construct and fully test each board, rather than try and debug one large, complex board. The setup procedure for each PCB is relatively simple, and if nothing goes wrong all you will need is a voltmeter and the usual construction tools. Access to a conventional CRO will be useful, mainly for faultfinding and testing.

Having whetted your appetite (I hope), here's an overview of the project.

An overview

The basic principle of operation is that an input signal, after amplification, is converted to a digital signal for subsequent storage in a 2K byte static RAM IC. Once the waveform is stored it is then read out to the TV screen. The unit can be set to automatically read and display, or the waveform can be stored and locked for display as long as you wish.

The resolution is 128 pixels across by 128 lines down, giving a total of 16K pixels. A conventional CRO has a greater resolution, but when you consider that the waveform can be up to the full height of a monitor screen, the loss of resolution is compensated by the size of the display.

To allow voltage and frequency to be measured, a graticule is also displayed. The whole circuit is based around a 12MHz master oscillator, and the calibration is therefore limited only by the crystal. The 12MHz oscillator is used to generate all the synchronising pulses for the TV set, the timing signals and also the sweep signal that stores the input signal. How this is achieved will become clear, and if I do say so myself, it's clever.

The A to D converter is probably unique in the annals of electronic circuitry, and is really very simple. It uses the good old DAC0800 chip, plus a comparator.

That's all, believe it or not! It works by scanning the input signal 128 times, one sweep of the input per display line on the TV screen. The TV monitor uses 128 lines of the available scan lines to show the input signal, although by way of some sneaky switching, 256 lines can also be used.

Because of the 12MHz timebase, the vertical scan frequency is actually around 60Hz, rather than the Australian standard of 50Hz. Virtually all computer monitors can handle a 60Hz vertical scan rate, as this is the standard in the US. The number of lines per frame is therefore around 256, rather than the usual 312.5 lines as per the Australian standards. Interlaced scanning is not used, as there is no benefit.

The project comprises three circuit boards, and the first, described in this article generates the synchronising pul-

ses for the video monitor and all the timing signals for use by the other two boards.

The second board contains the amplifier for the input signal and the circuitry that generates the graticule. The third board, which is the most complex, contains the A to D converter and the circuitry that stores the input signal into the RAM IC for subsequent display.

Your question now is probably, "Is this project really a replacement for a conventional CRO?"

The limitations

The first point to make is that the bandwidth is limited to 1MHz. At this frequency, some 10 cycles are displayed, which although adequate for display purposes, is not as good as a conventional 20MHz CRO — which can resolve a 1MHz input to around 1 cycle on the screen. But then, the cost of this project will be far less than purchasing a 20MHz CRO, and many users don't require such a bandwidth anyway.

The other limitation is that low frequency signals (less than 300Hz) take quite a while to be stored. For example, a 50Hz signal takes around six seconds to be stored, if the sweep settings are adjusted to give a display of one cycle or so.

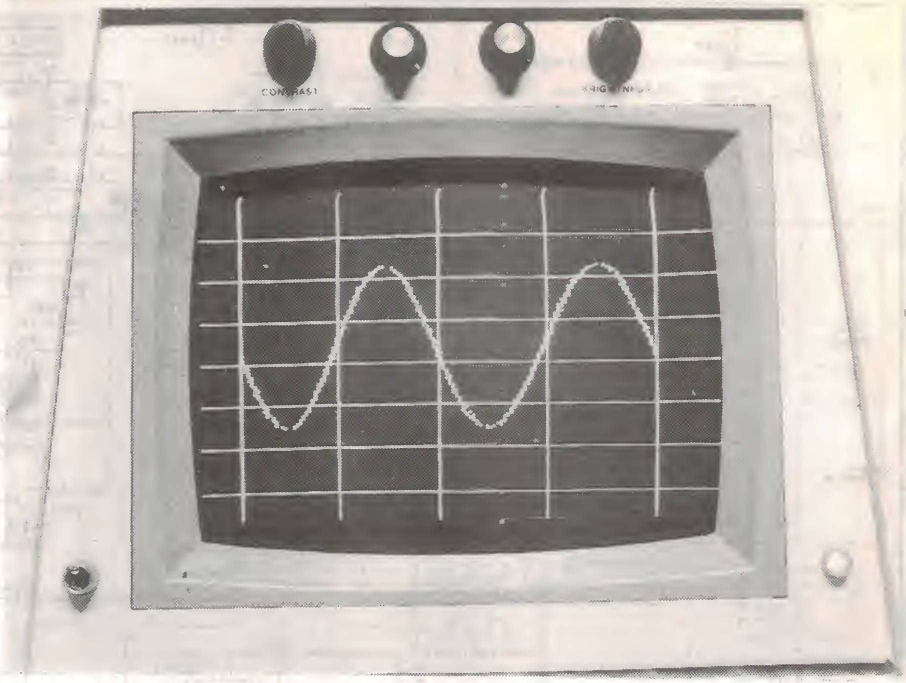
The solution to this is a one-shot ADC, but the problem of 'creeping specifications' kept me from resolving this minor difficulty. After all, the circuit is complex enough, and adding another type of analog to digital converter for low frequencies would put the project into the 'too complex' category for many constructors.

But is this project good enough to replace a conventional CRO? Well, that depends on your needs.

If your main use for a CRO is in audio applications, then this project will probably fulfill your needs. If you don't have a CRO of any sort, then this unit will definitely fill a gap in your line-up of test equipment.

If you already own a CRO you will find this project an excellent addition, as it can provide yet another means of examining waveforms. And being able to store a waveform must be useful as well.

So whether to build or not or to build is a question only you can answer. But a CRO for less than $100 (without the case) is probably attractive to most readers, hence our reason for saying this project is one of our most exciting for some time.



This photo shows the display of a 10kHz sinewave on a composite monitor. The graticule can be switched off if required, or the number of horizontal lines changed from seven to three.

The display device

Most TV-CRO adapters usually operate with a conventional TV set via a modulator. However, this project is designed for use with a computer monitor.

There are several reasons for this, including the ready availability of such monitors. It will work with a composite monitor or a TTL type monitor, and the photos in this article show both types in operation.

The main reason for not using a conventional TV set is the quality of the display. The bandwidth requirement is around 4.5MHz, which is almost the limit for a normal TV set.

Most computer monitors have a bandwidth of 10MHz or so, giving a much sharper display. Anyone who has tried using a TV set to display computer text will know the limitations of this sort of arrangement, particularly if the input signal is fed into the antenna terminals via a modulator!

However if a conventional TV set is supplied with a video signal directly to the video amplifier, rather than having to run the gamut of the tuner, the IF stage and the video demodulator, the display will be improved. It's probable that many readers have operated a TV set from a computer using direct video and this project could be connected in the same way.

Because all TV sets differ on how to cut into the video section, I'm not going to describe how this can be achieved, but simply say that if a computer can drive the set directly, so can this project.

There are two video outputs from the adapter: composite and TTL. The TTL connections are compatible with the IBM MDA standard (and CGA without the colour), as these monitors use standard scan frequencies.

The standard polarity for the vertical sync for a TTL monitor is negative, although the monitor used with the prototype worked fine with positive sync. If you have problems, a pad has been included on the PCB design to take the vertical sync to the DB9 socket from pin 12 of IC4. This output gives negative-going vertical sync.

The composite output has positive-going video (like a computer), in which an increase in output voltage produces an increase in brightness.

This is the opposite to the Australian broadcasting standard, which uses a negative polarity, in which the sync pulses are 'on top' of the video signal.

So really, any type of video monitor is suitable, except the project does not support signal input via the aerial terminals of a conventional TV set. However we recommend a computer monitor of some sort, as the linearity and bandwidth are generally better than most conventional TV sets.

Having given you a broad descrip-

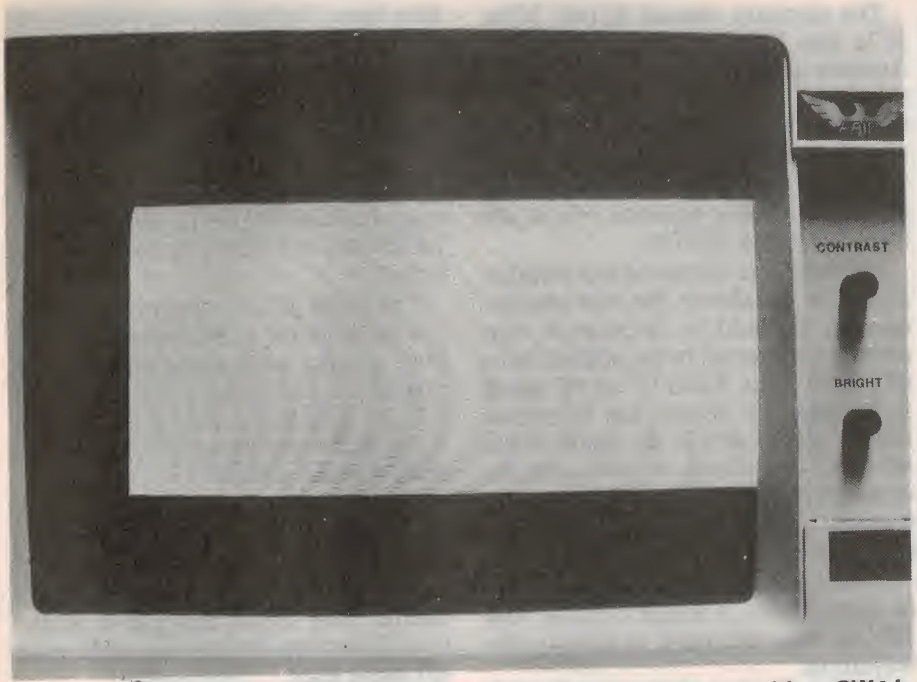


***Fig.1:** The display you should see when SW3a is set to the x1 position, SW4 is set to 'block' and the sync frequencies are correctly set. A TTL monitor is being used in this shot.*

tion of the project we can now get down to the first section, referred to as PC board 1. First a look at how this section works, then how to construct it and get it going.

PC board 1

This board contains several independent sections of the whole TV-CRO circuit, but its main task is to produce the synchronising signals for the video monitor. A 12MHz crystal oscillator is formed around IC1a to IC1c, and its output is applied to the first of two counters (IC2 and IC3) which act as frequency dividers. A number of outputs from these two counters are connected to SW1, which is the equivalent to a Time/Div switch on a conventional CRO.

To produce a frequency of 15.625kHz from 12MHz requires division by 768. As this is not a number in the binary series, it needs to be achieved in two stages. Output Q7 of IC2 represents a division of 256, giving 12MHz/256, or 46.875kHz. If you divide this frequency by three, up comes the required 15.625kHz. The 46.875kHz signal is fed to IC4, which is a dual timer IC (74LS123) in which timer 1 is used to produce the 15.625kHz output.

The feedback from Q1-bar to input B1 and correct settings for the timing components make this timer respond to every third pulse at input A1, and the required 15.625kHz output appears at output Q1. However there is a glitch midway between the output pulses, and R5 and C4 are required to eliminate this unwanted pulse.

The output Q1 of timer 1 (pin 13) is used to trigger IC5, a 555 timer wired as a monostable and it also eventually ends up at the output of the video buffer Q1 as the horizontal sync pulse. The 555 timer is used to produce a variable width horizontal sync pulse called Hd, where d stands for delay. The effect of varying the width of this pulse is to move the display on the screen horizontally, giving an X-shift control which allows the waveform to be moved across the screen to align it with the graticule.

The output of IC5 is connected to several points in the circuit, including the DB9 connector for the TTL monitor and the clock input of counter IC3. It is also inverted by IC10d for use in other sections of the circuit, yet to be presented.

To obtain the vertical sync pulse, output Q7 of IC3 is fed to timer 2 within IC4. This signal is a 61.035Hz square wave, and the timer is required to set the mark-space ratio to give the correct width for the vertical sync pulse. Output Q2 of timer 2 (IC4 pin 5) is then connected to the DB9 socket, and is also EX-ORed with the horizontal sync pulse to give the composite sync signal required.

The next section to describe is the function of IC9. The video output signal derived from the memory IC on PC board 3 is not directly suitable as a display. Without IC9, a waveform is displayed with the area under the outline of the waveform 'filled in'. With IC9, only the outline of the waveform is shown.

The reason is that the output of the memory is either a high or a low, in which a high lights the screen and a low doesn't. If a high appears at line 1 on the screen (outline point of the

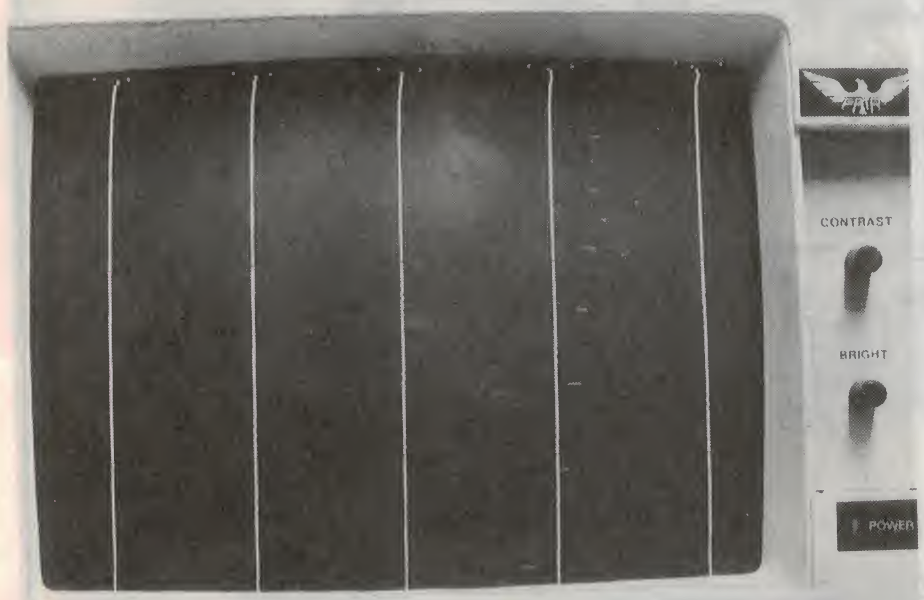


***Fig.2:** If the TTL video input point is connected to the 47kHz output of IC2, you should see this display when SW4 is set to trace. Adjusting VR3 and VR4 will set the width of the lines.*

waveform) it will also be present at line 128 and all lines between. To obtain the outline of the waveform, only the *changes* in the data are required.

To achieve this, the digital data from the memory is used to trigger the two timers of IC9. On the rising edge of a logic 1, an output pulse from timer 1 (pin 4) will occur. On the falling edge an output will be produced by timer 2 at pin 12. These are NANDed by IC10a, then fed to the video output transistor. The width of the pulses are both adjustable, to set the pixel width on the screen.

However not all waveforms are constantly changing. For example, the top or bottom of a square wave has a constant value, and because IC9 only produces an output when there is a change, the effect is a square wave on the screen with no top or bottom.

To overcome this, SW4 is used to select either the outline of the waveform (trace) or the 'filled in' (block) version.

The circuitry around IC10d, IC8a, IC7a and IC7b is rather complex to describe and its purpose is to produce the signal that clocks the data *out* of the memory IC. Remember that the signal is scanned in at a rate determined by the setting of SW1, but the signal is always scanned out at the same frequency (3MHz).

Although the circuit of the memory section is not shown, the read-out frequency is used to increment two counters connected to the address lines of a 6116 static RAM IC on PC board 3. Because the display has to be stationary and located in the centre of the screen, the clock to the address counters needs to be gated so that the read-out occurs at the same time for each frame.

It works like this: there are 256 lines in each frame (15625/61.0352), and 128 of these are used to display the waveform.

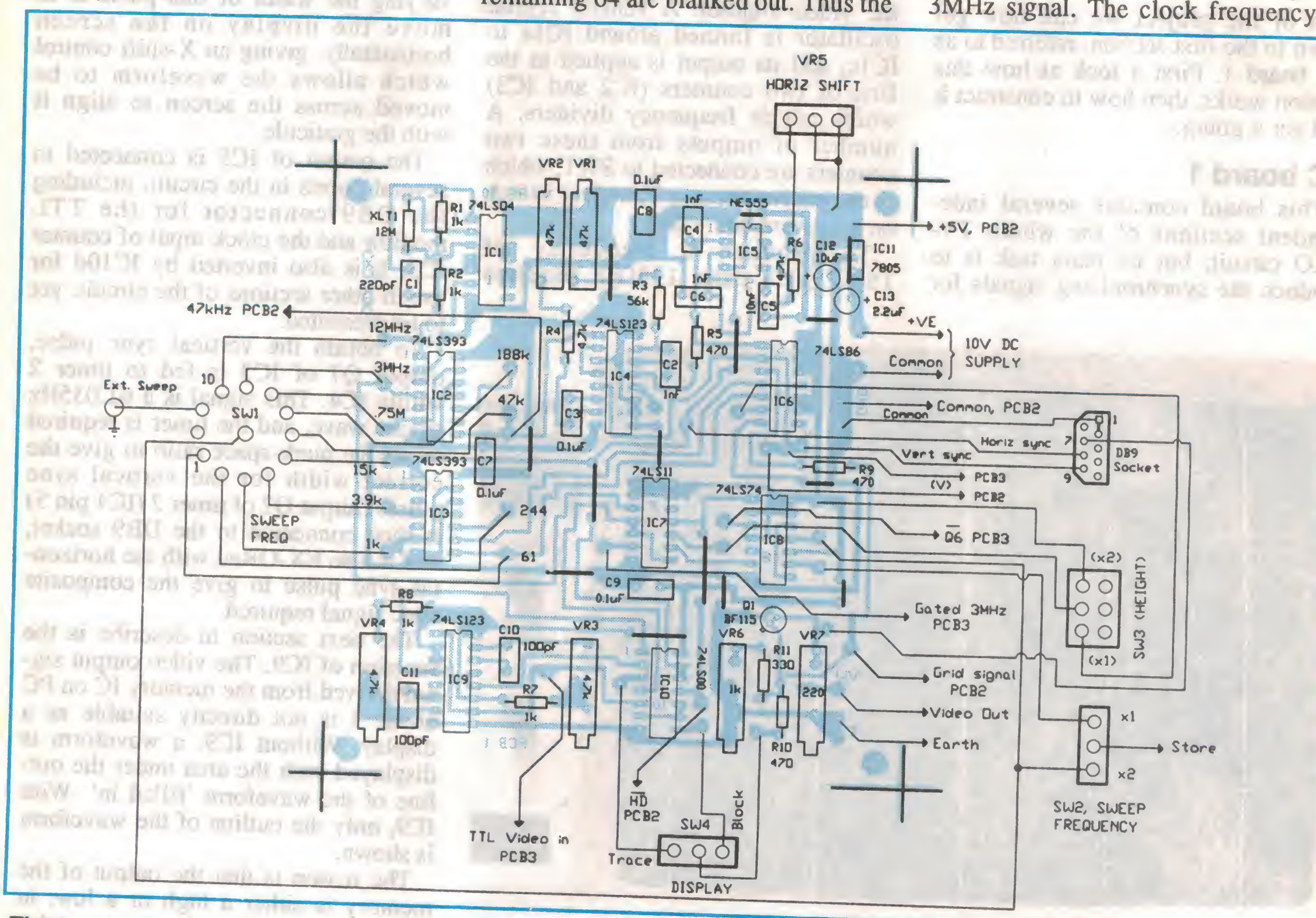
To obtain a central image, the first 64 lines are blanked out, then 128 lines are used for the display, after which the remaining 64 are blanked out. Thus the data from the memory is clocked out during lines 64 to 127, assuming line 0 is the first after vertical retrace.

There are 128 pixels used in each line, and to prevent overscan, only a section of each scan line can be used. Clocking for each line occurs following a suitable delay after each horizontal retrace, and then only for 128 clock cycles.

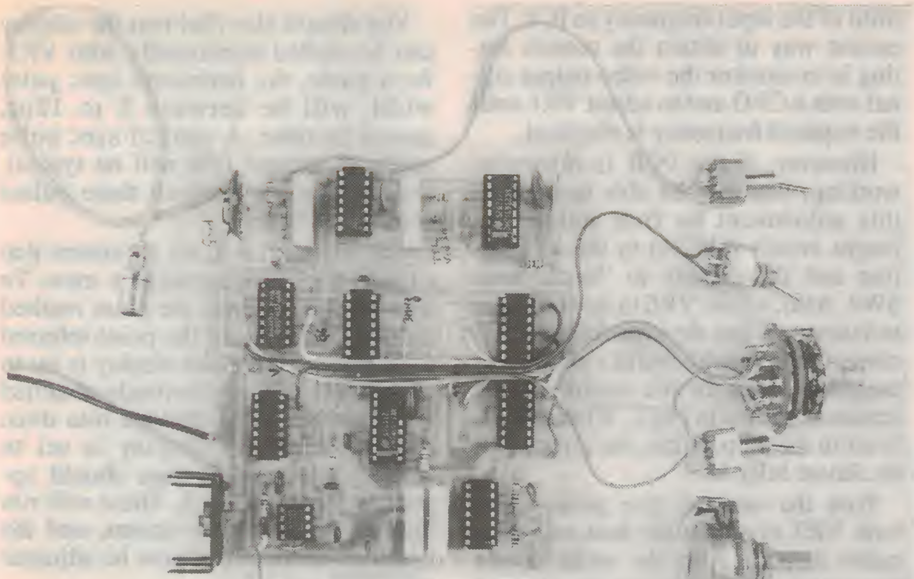
The delay before clocking commences on each line is controlled by pulse Hd, and the scan lines that have to missed are controlled by the output of EX-OR gate IC6b. This gate produces a signal derived by combining signals related to the vertical sync frequency.

To ensure there are only 128 clock cycles per scan line, feedback from one of the address counters on PC board 3 is also included in the gating circuit. This signal sets pin 6 of the type D flipflop (IC8a) low, and pulse Hd sets it high.

The final result, produced by IC7b, is a clock signal to the address counter, referred to on the circuit as the gated 3MHz signal. The clock frequency is



The layout diagram for PCB 1. To make things easier the component values as well as their designators are included. A pad is included on the PCB that connects to pin 12 of IC4 which outputs negative going vertical sync pulses, in case your TTL monitor won't work with the positive vertical sync supplied by the layout as shown.



This shot shows PCB 1 fully assembled. The wiring connecting it to the other two boards has not been fitted at this stage. An IC socket pin fitted to the point marked 'TTL Video In' will be useful for test purposes.

3MHz, as 128 cycles take 42.67us, which is less than the available scan time of 54us (64us period less the retrace time of 10us). I know it sounds complicated, but the end result is a display that doesn't extend beyond the available width of the monitor picture tube. To allow all 256 lines to be used to display the waveform, SW3A is used to disable the 61Hz gating signal from IC6b. The second half of this switch is connected to the address counter on PC board 3. Also, a gating signal from this section is fed to IC10b, to blank out the unwanted part of the screen when the 'block' display is being used.

Finally, IC8b is used to give a divide-by-two function for the sweep frequency. There are thus 20 available sweep frequencies to read the signal into the memory.

IC11 is a 5V regulator used to power the circuit. The video output is taken from the wiper of VR7, and VR6 sets the relative height of the video signal to the sync signal.

The setup procedure mainly requires the timers of IC4 to be set to produce the correct sync signal and the timers of IC9 to be adjusted to give a suitable pixel width. The adjustments around Q1 are not critical and are set to suit the monitor being used.

Construction

Construction of the first board is relatively straightforward. Start with the usual check of the PCB itself, by confirming there are no faults in the way of shorts between adjacent tracks or open circuits in some of the thinner tracks. If not already present, drill the four mounting holes to a size that fits the mounting hardware you intend using, such as nylon PCB supports.

Fit the 12 wire links first, then solder all the IC sockets in place. Sockets are not essential, but their additional cost will be well justified in the event of a fault occurring. Then stock the PCB with the passive components as per the layout diagram. The only polarised components are the tantalum capacitors C12 and C13, and as usual take care with their orientation.

The trimpots are all 10-turn types except VR7, which can be a conventional vertical mount type. The PCB pattern allows either type to be fitted for both VR7 and VR6, as neither of these are highly critical. Fit the trimpots and then solder Q1 in place. This transistor has four leads, (one lead is the case, which connects to ground), so take care to orientate it correctly.

At this stage, don't fit the ICs or the crystal as the switch wiring needs to be completed first. There are four switches and one panel-mount potentiometer connected to the PCB, and the wiring to these should be as short as is reasonable. The PCB is intended to mount about 30mm from the front panel holding all the controls, and some of the wiring can be routed as a loom.

Use a 10cm length of 10-way ribbon cable to connect SW1, with the 61Hz frequency output from IC3 connected to the most anti- clockwise position of the switch. A conventional wafer switch, rather than the totally enclosed type was used in the prototype, as it was found to be more reliable for this application. The sweep multiplier switch, SW2 connects to the common of SW1 and this wire also connects to the PCB at pin 11, IC8. The lead lengths for SW2, SW3 and SW4 will be around 16cm, and the wires for SW2 and SW3 can be routed along the centre of the PCB. Connect VR5 using two wires cut to approximately 20cm.

An RCA socket can now be connected to the video output pads of the board with a 20cm length of shielded cable. The DB9 socket for a TTL monitor can also be connected if this sort of monitor is being used as the display. There are several more wires that connect this board to the other two PCBs, but these are best fitted once the other boards have been constructed and tested.

Now is the time to insert all the ICs and to fit the regulator IC11 and the crystal. Fit a small heatsink to the regulator, arranged so it doesn't foul any components or wires. Two wires are also needed to supply power to the board, and both of these should be 1 amp hookup wire rather than unused wires from the ribbon cable.

Now spend five minutes examining the board for any construction errors, particularly for solder bridges between adjacent tracks.

Testing

Support the PCB in a holder, or place it on the workbench free of any scrap wire and connect a DC supply of around 10V. The current consumption should be in the order of 100mA, and the voltage output of the regulator should be measured to confirm it is 5V.

If everything seems OK so far, connect a computer monitor of a type described previously (must operate with a line frequency of 15.625kHz and a field rate of 60Hz). Set VR7 to give a maximum output and don't be surprised at the display. It could be anything from a fully lit screen to nothing.

The first thing to adjust is VR1, which sets the frequency of the horizontal sync pulses. The frequency will range between various divisions of the 46kHz input signal to IC4, from a quarter (11.72kHz) to a seventh (6.7kHz). The correct setting will give the required 15.625kHz, which is one

TV CRO Adaptor

PARTS LIST — PCB1

Resistors

All 1/4W, 5%

R1,2,7,8	1k
R3	56k
R4,6	4.7k
R5,9	470
R10	680
R11	330

Variable resistors

All 10-turn PCB mount unless otherwise noted

VR1,2	47k
VR3,4	4.7k
VR5	10k, panel mount linear
VR6	1k (can be vertical mount trimpot)
VR7	220 vertical mount trimpot

Capacitors

C1	220pF ceramic
C2,4,6	1nF polyester
C3	0.1uF polyester
C5	10nF polyester
C7,8,9	0.1uF mono or ceramic
C10,11	100pF ceramic
C12	10uF 25V tantalum
C13	2.2uF 25V tantalum

Semiconductors

IC1	74LS04 hex inverter
IC2,3	74LS393 counter
IC4,9	74LS123 dual timer
IC5	555 timer
IC6	74LS86 quad EX-OR
IC7	74LS11 triple 3 input AND
IC8	74LS74 dual D flipflop
IC10	74LS00 quad NAND
IC11	7805 TO-220 5V regulator
Q1	BF115 NPN transistor

Miscellaneous

XLT1	12MHz crystal
SW1	12-position single pole rotary switch
SW2,4	SPDT miniature toggle
SW3	DPDT miniature toggle
PCB,	120mm x 115mm coded PCB1;

DB9 panel mount socket,
10cm length 10 way ribbon cable,
IC sockets,
hookup wire,
10mm high mounting hardware for PCB,
small heatsink for regulator,
knobs to suit switch and potentiometer.

third of the input frequency to IC4. The easiest way to obtain the correct setting is to monitor the video output signal with a CRO and to adjust VR1 until the required frequency is obtained.

However, if the PCB is otherwise working, you may be able to perform this adjustment by first setting the height switch (SW3A) to the x1 position and the display to 'block' with SW4. Also, adjust VR6 to its *maximum* resistance. When the sync frequency is correct, you should obtain a single rectangular block in the centre of the screen as shown in Fig.1. When SW3A is set to the x2 position, the screen will be almost fully lit.

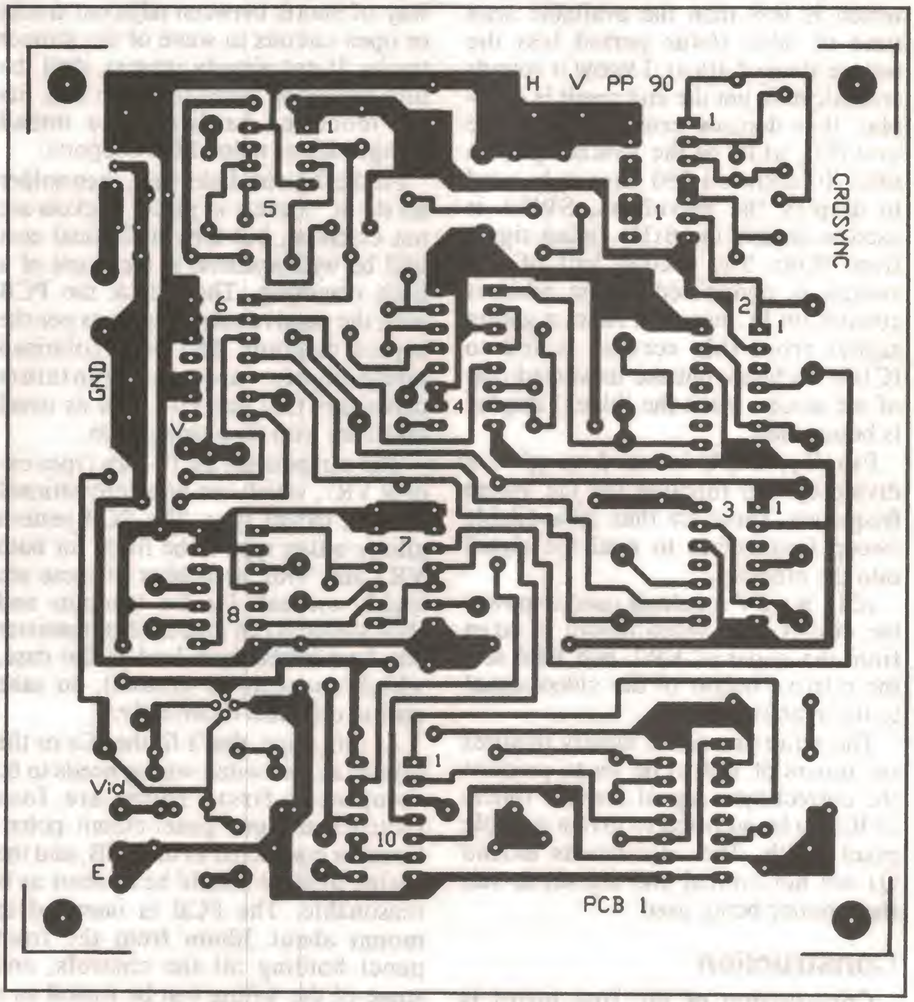
Trim the vertical sync pulse width with VR2 to obtain the best and most stable display. Also the width of the horizontal sync pulse can be adjusted by fine tuning VR1, again to get the best stability. The display may exhibit tearing, but this will not affect the final operation. Toggle between the x1 and x2 settings until the two displays are both stable and correct.

You should also find that the display can be shifted horizontally with VR5. As a guide, the horizontal sync pulse width will be between 8 to 12us, spaced by 64us. A vertical sync pulse width of around 1ms will be typical, and the spacing between these pulses should be 16ms.

The next step is to set the timers that convert the block signal to a trace. To achieve this, connect the point marked as 'TTL video in' to the point referred to as 47kHz. When the display is set to x1 and 'block', the previously obtained rectangle should be divided into three blocks. When the display is set to 'trace', five vertical lines should appear as shown in Fig.2. These will run the full height of the screen, and the width of the lines can now be adjusted with VR3 and VR4.

It is likely that the adjustments will be reasonably correct in the first place, and final adjustment is best performed when the whole project has been completed. Confirm that VR3 adjusts the

Continued on page 107



The artwork for the PCB is reproduced full size. This artwork, the circuit diagram and the layout diagram were all done using Protel.

The 'Flexitimer'

This handy little gadget uses just a handful of components to accurately time intervals from a few seconds to a whole day. It can switch a number of different output devices, and may be powered by a battery or mains plugpack.

by ROB EVANS

While you've probably noticed that this new project has a very simple circuit, don't be fooled into thinking that it has a limited number of uses. On the contrary, it's an example of how a basic 'open-ended' circuit can be used in a wide range of applications, by simply tailoring the end result to suit the job at hand. Although the actual schematic shows the timer in a specific arrangement, its delay time for example can be adjusted over a very wide range by just altering a couple of component values and board connections (more of this later).

So when the need arises for a timing circuit, be it a simple parking meter reminder or the basis of a full-blown watering system, the idea is that you can configure this design to suit. In fact it's the flexible nature of the circuit that prompted us to dub this project the 'Flexitimer'.

How it works

As you can tell from the schematic diagram, the Flexitimer's circuit really is quite simple. Basically, it consists of a 'clock' oscillator (IC1), a 14-stage ripple counter (IC2) and an output switching transistor.

The clock circuit is based on the ubiquitous 555 timer IC, which is arranged in a standard astable configuration. With the values shown for R1, RV1, R2 and C1, the circuit oscillates at about 1Hz when pin 4 (reset) of IC1 is high, and RV1 is set to around its maximum resistance. The resulting squarewave at the 555's output (pin 3) is then applied the counter's clock input (pin 10 of IC2).

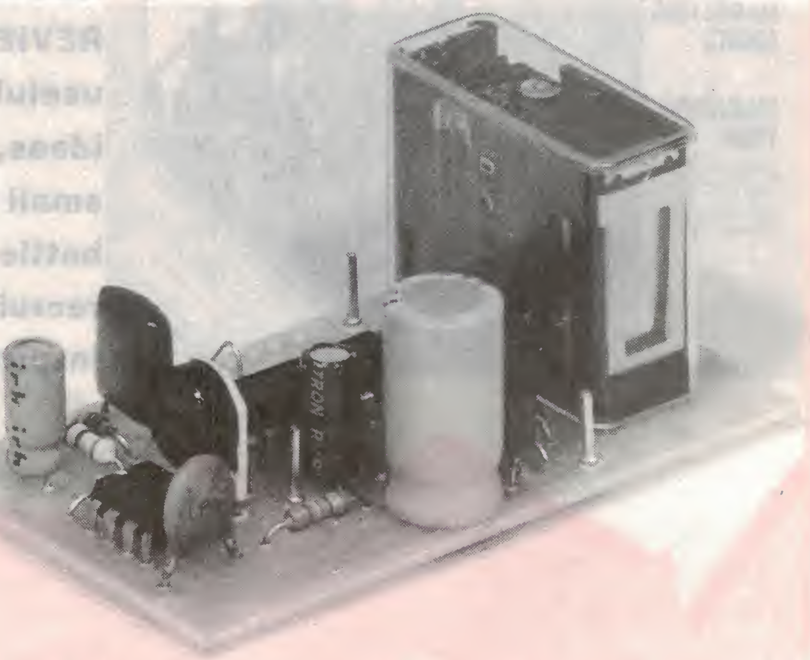
The counter chip is a 4020 CMOS device which advances its count on each negative transition of the clock pulse, and can be set to the zero state (all outputs low) by a high logic level on the reset pin (pin 11). In the Flexitimer, C3, R3 and D1 are arranged as a power-on reset circuit so that the counter will always advance from its 'zero' state.

Since C1 is initially in a discharged state, pin 11 will be pulled high and the counter reset when power is first applied to the unit. C1 will then charge via R3, allowing the voltage at pin 11 to fall — this reaches a low logic level in around 50ms, and the counter is enabled.

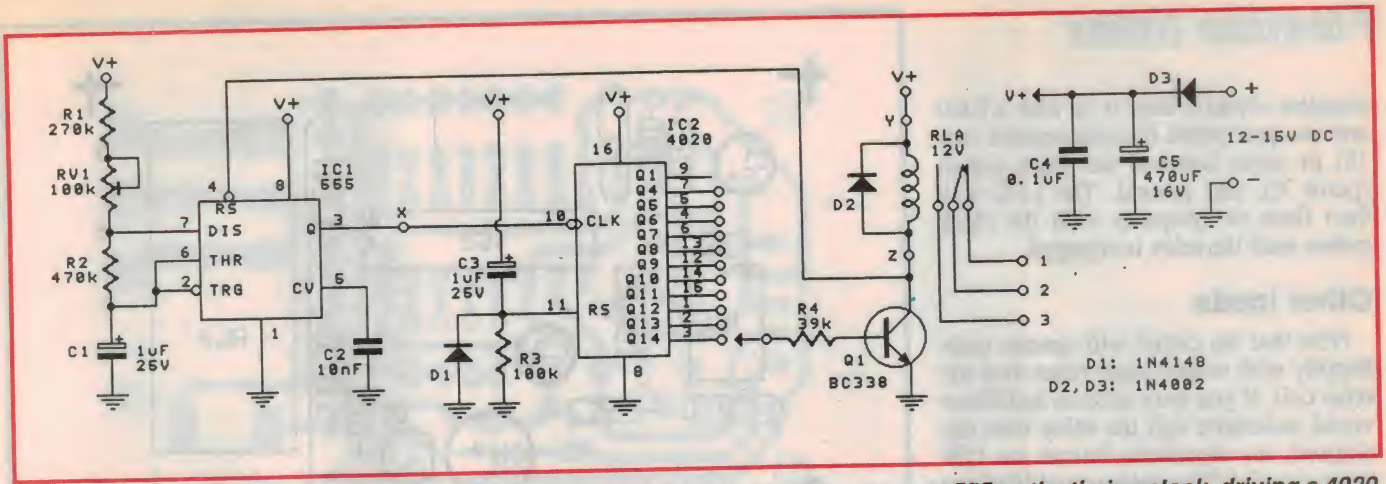
IC2 then counts clock pulses from IC1 until the selected counter output goes high, which in turn biases Q1 hard-on via R4. If the Q14 output is used as shown in the schematic, the clock frequency is divided by 2^{14}, or 16,384. Now, if the clock is running at exactly 1Hz, we will have a frequency of around 60 microhertz (1/16384) at the Q14 output — or in more realistic terms, a cycle period of 16,384 seconds. Since this figure represents a *full* cycle (low-high-low), the output will change to a high state in half of the period, or 8,192 seconds.

At the end of the above period, the high level at Q14 will force Q1 into saturation, which in turn energises the output relay RLA. Since the clock reset pin (pin 4 of IC1) is tied to the collector of Q1, the 555 will be enabled during the timing period (pulled high via RLA's coil), and disabled after the time has elapsed (pulled low by Q1's collector).

As you would expect, the Q14 output will remain high at the end of the timing period since IC1 is no longer providing clock pulses to the counter. Therefore, with the circuit components as shown, the relay will be energised 2 hours, 16 minutes and 32 seconds (8,192 seconds) after power is applied to the unit. The relay's closing contacts (normally-open)



The new timer forms a very flexible 'building block' module, which lends itself to a wide variety of timing applications.



The schematic for our new Flexitimer. As you can see it uses only two ICs — a trusty 555 as the timing clock, driving a 4020 multi-stage binary counter. Transistor Q1 drives the output relay, or other output load.

may then be used to connect power in an external circuit, or the opening contacts (normally closed) used to disable (disconnect) an active circuit.

The timer's overall delay can be 'fine tuned' by altering the value of the trimpot RV1. In the above example, if RV1 one is moved towards the centre of its travel for a resistance of 55.7k, the clock would be theoretically running at 1.1378Hz and the delay time reduced to exactly 2 hours (7200 seconds). This is indeed theoretical however, since in practice the value of the circuit components won't exactly match their rated values — for a specific time delay, RV1 will need to be adjusted on a trial and error basis.

The remaining parts of the circuit are included to protect the semiconductors, and provide a stable supply rail for the 4020 counter chip. For example, D3 is connected in series the positive supply rail to prevent any current flowing in the circuit if the power supply connected the wrong way around — that is, with a reversed polarity. The associated capacitors, C5 and C4 help to filter low and high (respectively) frequency interference from the supply rail. Also, D2 damps the back EMF of RLA's coil, while D1 provides a discharge path for C3 when the unit's power supply is disconnected.

Options

With the circuit connected as shown in the schematic, the Flexitimer will latch the relay in around 2 hours (depending upon the adjustment of RV1). However if the counter's Q13 output is used, the circuit will reset after 4096 clock pulses or 3600 seconds (1 hour). Similarly, the Q12 connection corresponds to 2048 counts or 1800 seconds (30 minutes) — and so on. Finally, the Q4 output (the smallest division in our circuit) will reset the circuit in just 7 seconds.

```
10   PRINT"CHECKS FINAL DELAY TIME OF `FLEXITIMER'
20   PRINT
30   INPUT"Value selected for R1 (k)";R1:IF R1=0 THEN SYSTEM
40   INPUT"Value selected for R2 (k)";R2
50   INPUT"Value selected for C1 (uF)";C
60   INPUT"Q output used from counter (n)";N
70   F=1.44*1000/((R1+2*R2)*C)
80   D=100*R2/(R1+2*R2)
90   T=(2^N)/2/F
100  H=FIX(T/3600)
110  M=FIX((T-(H*3600))/60)
120  S=FIX(T-(H*3600)-(M*60))
130  PRINT
140  PRINT"The timer will reset in";H;"hours,";M;"minutes and";S;"seconds
150  PRINT"- the clock is running at";F;"Hz, with a";D;"% duty cycle.
160  GOTO 20
```

Fig.1: A simple BASIC program which can be used to estimate the final delay time of the Flexitimer, given the values for R1, R2, C1 and the output from IC2 that is being used to drive Q1.

However the unit can easily be programmed to cover a wide range of other time delays by simply changing the IC1 clock rate, which can be set between fractions of a hertz up into many kilohertz. This yields an overall (practical) timing range from a few seconds to about 24 hours.

To help with the calculations we have included a simple BASIC program (Fig.1), which estimates the final delay time of the Flexitimer as determined by the circuit components. The clock frequency is calculated at line 70, the clock duty cycle at line 80, and the overall time in seconds at line 90. If you haven't the facilities to run the program, you can use a calculator and the equations at the abovementioned line numbers. Note that 'R1' in the program represents the *total* resistance between pin 7 of IC1 and V+ in the circuit diagram. In the practical sense, this would be the actual resistance of RV1 at its current setting, *plus* the value of R1.

To try out the program, try typing in the component values mentioned in the 'how it works' section where the circuit has been 'fine tuned' (the total value for 'R1' will be 325.7k).

Rotary switch

If you find that a number of different time delays are necessary for your application, a 12-position rotary switch could be wired into the circuit between the counter outputs and R4. As you would expect, the time is then reduced by a factor of two (halved) as each lower-order Q output is selected.

Also, you may like some visual indication that the timer is operating — the circuit normally appears quite passive until the relay is pulled in. The

simplest solution here is to wire a LED and an appropriate limiting resistor (say 1k) in series between the clock output (point X), and ground. The LED will then flash in sympathy with the clock pulses until the relay is engaged.

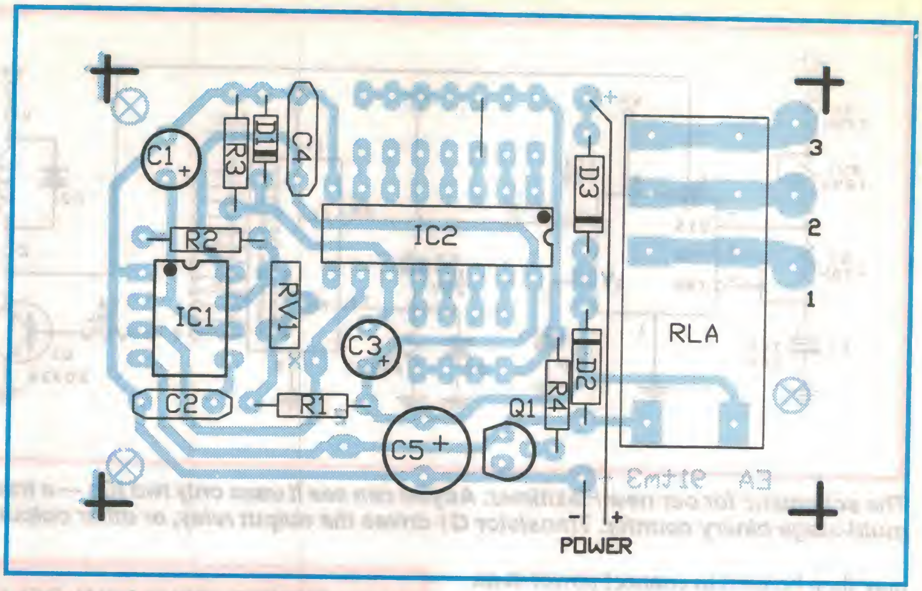
Other loads

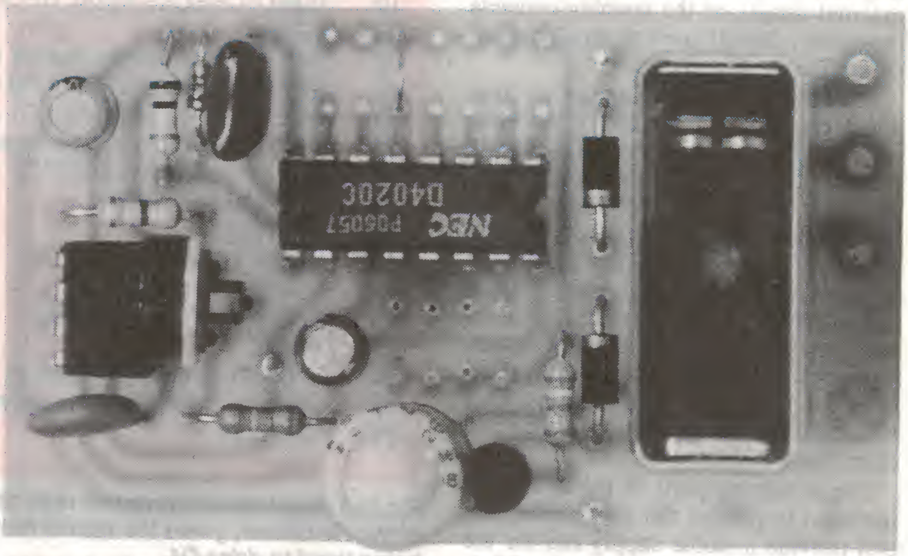
Note that the circuit will operate quite happily with output loads other than the relay coil. If you only need an audible or visual indication that the delay time has elapsed, an electronic buzzer or 12V lamp (or LED/resistor combination) could be installed in place of RLA. These can be connected to the PCB at points Y and Z, or RLA's coil connecting pads.

When the Flexitimer is driving these types of loads (say a buzzer or LED) instead of the relay, the circuit may be battery-powered since the overall current consumption is quite low. While the schematic diagram shows a voltage source of 12 to 15 volts, the circuit is quite suited to a standard 9V 216-type battery. To reduce the unit's size even further, you could cut off the section of PCB that normally supports the relay and use the Y and Z pads to connect the load.

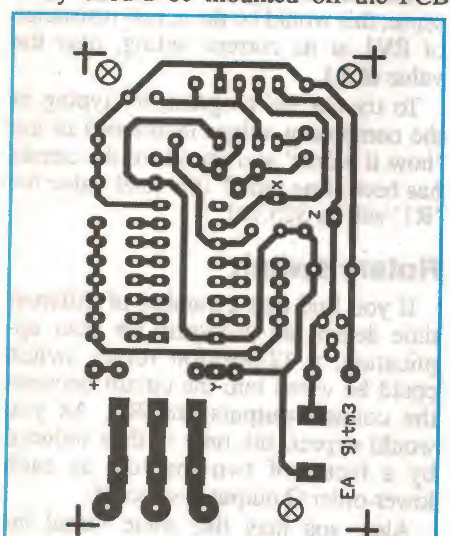
If you *are* intending to use the relay on the other hand, we can't recommend that its contacts are wired to the 240V mains supply — combining low-powered circuitry and mains voltage on such a small PCB is just too risky.

If experienced constructors still wish to use the circuit in this manner, the relay should be mounted off the PCB and the complete unit housed in an insulated case. Naturally, any exposed mains wiring should be thoroughly insulated, and any switches used must be rated for 240V mains applications.





At top is the PCB overlay diagram, showing where everything goes and the orientation of the polarised components. Above is a shot of the prototype timer — note that RV1 was at that stage a little too close to IC1, and similarly with Q1 and C5. These spacings have been fixed in the artwork shown at lower left.



Here is the artwork for the timer PCB, reproduced actual size.

Construction

Building the Flexitimer is a very straightforward process, since all of the components fit on one small printed circuit board (PCB) coded 91tm3. This measures only 69 x 38mm.

Commence construction by first checking the PCB for any etching anomalies, such as shorted or broken tracks. Then install the components onto the board as shown in the component overlay, working through from the low to high profile parts — pay particular attention to the orientation of the polarised devices such as electrolytic capacitors and semiconductors.

The 4020 IC is a CMOS device, and should be protected against static voltages by earthing the PCB ground track, the soldering iron (which should already be grounded) and the handling tools. Solder the 4020's power supply pins first — these are pin 8 (earth) and pin 16 (V+). Don't forget to install the link at your chosen Q output.

The final construction stages will depend upon the options you have selected, and the final use of the Flexitimer. For portable use with a buzzer or LED output, simply wire an on-off switch in series with the positive battery lead and install the complete unit in a small plastic case. In a fixed application using the relay as an output device, you

PARTS LIST

1 PCB 69 x 38mm, coded 91tm3
1 Standard 12V DPDT relay, 200 ohms or greater.

Semiconductors

1 555 timer IC
1 4020 14-stage binary counter
1 BC338 NPN transistor
1 1N4148 (or similar) diode
2 1N4001 (or similar) power diodes

Resistors

All 0.25W, 5%:
R1 270k (see text)
R2 470k (see text)
R3 100k
R4 39k

Capacitors

C1 1uF 25V PCB-mount electrolytic (see text)
C2 10nF metallised polyester
C3 1uF 25V PCB-mount electrolytic
C4 0.1uF metallised polyester
C5 470uF 25V PCB-mount electrolytic (or similar)

could mount the timer inside the case of another unit — this might be a watering system, vehicle (it has a large case!), house alarm, etc.

However, it may be advisable to check that the timer is operating correctly before commencing an ambitious installation job. Fortunately, this is quite simple — just apply power to the circuit and note that the relay is energised by Q1, after the intended time delay. If Q1's collector doesn't go low on the other hand, check that the clock is delivering pulses at point X and the chosen Q output is being driven high after the correct number of counts.

If the clock chip (IC1) is not running, check the level at pin 4 — this should be pulled high via the load during the timing period. The reset pin (pin 11) of IC2 is worth checking if there is no activity at any of the counter's Q outputs — this is normally at a low level, except for a brief high-going pulse when power is first applied to the unit.

Note that if the timer is powered by a plug pack that has a high source resistance, the supply rail may initially rise quite slowly (due to the charging action of C5). This means that IC2's reset circuit (C3, R3 and D1) may not function correctly and the counter will not advance from its cleared state, leading to erratic or inaccurate time delays. If this is the case, try increasing the value of R3 to say 330k; this will allow the slower rising edge of V+ to be transferred to the counter's reset pin. ■

Jack O'Donnell
Managing Director

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Max. Power...60W
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Res. Freq.......70Hz (+/-14Hz)
Sensitivity.....96dB/W(0.5m)
Magnet..........567 gm/20oz

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60 Watts RMS 100W Max.
Rated Power 60W
Max. Power...100W
Impedance....8ohm
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Res. Freq.......60Hz (+/-12Hz)
Sensitivity.....98dB/W(0.5m)
Magnet..........848gm/30oz

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Rated Power 80W
Max. Power...130W
Impedance....8ohm
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Res. Freq.......28Hz (+/-5Hz)
Sensitivity.....97dB/W(0.5m)
Magnet..........1170gm/41oz

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Max. Power....160W
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Res. Freq.......25Hz (+/-5Hz)
Sensitivity.....98dB/W(0.5m)
Magnet..........1408gm/50oz

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100 Watts RMS 200W Max.
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Max. Power...200W
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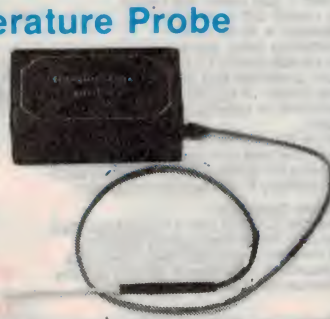

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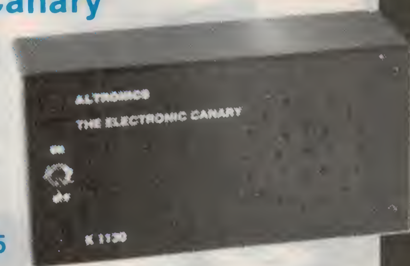

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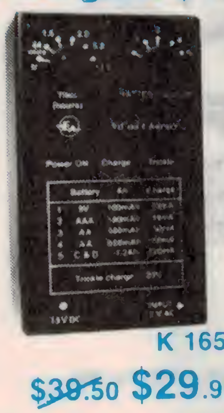
(See EA July '89)



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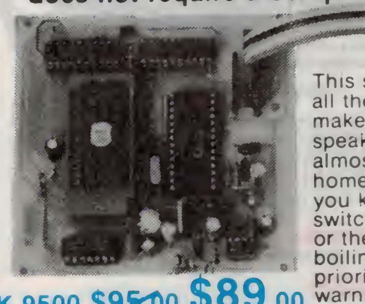

(ETI March '88)

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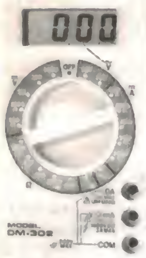

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AC Voltage Range: 200mV, 2V, 20V, 200V, 750V
Input Impedance: 10M Ohm
DC Current Range: 200uA, 2mA, 20mA, 200mA, 10A
AC Current Range: 200uA, 2mA, 200mA, 10A
Resistance Range: 200Ohm, 2k Ohm, 20k Ohm, 200k Ohm, 2M Ohm, 20M Ohm, 2000M Ohm
Capacitance Range: 2000pF, 20nF, 200nF, 2uF, 20uF
Transistor hFE Base DC Current: 10uA, **VCE:** 2.8 +/- 0.4V
General: Display: 3 1/2 digit liquid crystal with maximum reading of 1999
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The main control receiver runs on 240V AC with a 12V 1.2AH battery for emergency backup. All other units with the excepion of the line carrier, run on a 9V battery each. The average life expectancy is approximately one year. System works around 305MHz frequency where there is less chance of false alarm. The range of the unit is normally 80 metres in open space.

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Keep it at the bedside table — allows you to arm the house perimeters when you retire or you can take it with you when you go out, arming your system after you lock the door.

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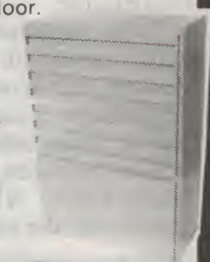
Remote Piezo Alarm



This unit is an optional line carrier receiver. Receives signal through 'AC' line i.e. it would ideally be located in, say, the roof space and plugged into mains power.

S 5290 ~~$125.00~~ **$89.00**

Detector/Transmitter Unit (Reed Switch) Suitable for Windows and Doors

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NEW PRODUCTS

New Scope solder station

Scope has announced a new version of its 60W 'zero cross' solder station. Model ETC60L-1 has a new circuit designed to allow the LED bar temperature display to be used for both setting and reading the selected temperature.

Other features include a 'floating earth' option for soldering sensitive devices, a time out or 'Auto switch off' version which can reduce tip corrosion and a useful add-on solder dispenser which reduces bench clutter and frustration when someone has 'borrowed' the solder reel!

For more information, circle 241 on the Reader Services Coupon or contact Scope Laboratories, PO Box 63, Niddrie 3042; phone (03) 338 1566.

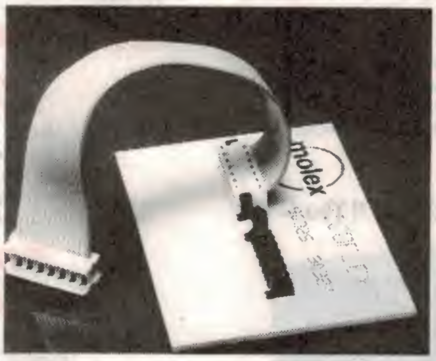
Vacuum pen

Emulation Technology's new product, the Vacuum Pen, has been designed specifically for the insertion and extraction of plastic quad flat pack and small outline integrated circuit chip packages.

The hand held pen has a vacuum 'built in'; no external hoses or equipment is required. The exterior of the pen is stainless steel; the plunger is plastic. It comes with three rubber cups to fit a variety of chip sizes. The Vacuum Pen solves the problem of bending the fragile and closely-spaced pins on modern chips.

For more information, circle 242 on the Reader Services Coupon or contact P P Component Sales, PO Box 580, Bayswater 3153; phone (03) 764 5199.

Wire-to-board system



Recently released by Utilux is a miniature wire-to-board, insulation displacement interconnect system from Molex. Using 1.27mm spacing ribbon cable, the system can be used in single ended, double ended and daisy chain applications.

Known as 'Picoflex (PF50)' the system offers substantial space savings of up to 50%. It is designed for the telecommunications, security, data and consumer markers and is available in several circuit sizes.

For more information, circle 244 on the Reader Services Coupon or contact Utilux; phone (02) 50 0155.

Smart timer with LCD readout

Email Electronics has added a new timer to its range of SMART series relays. The 2T361 version is characterised by a high contrast LCD on the front panel with 8mm digits. Information regarding pre-set time, countdown, relay status, mode selection and time units are displayed for easy interpretation.

In all other respects the Australian designed and manufactured 2T361 is identical to the 2T360 model released last year.

Both series are suited for OEM applications and service requirements. Virtually any eight pin timer relay in the field can be replaced without the need for time consuming and expensive re-wiring.

For more information, circle 245 on the Reader Services Coupon or contact Email, 15 Hume St, Huntingdale 3166; phone (03) 544 8244 or 008 331 386.

Electronic blocks

Elan Schaltelemente GmbH manufactures a comprehensive range of electronic block switches for various applications.

These contact blocks function on the light-barrier principle, by means of photoconductive cells and luminescent diodes with practically unlimited life.

Connected to the photoconductive cell is a transistor switching amplifier with a Schmitt trigger characteristic, so that signals of high edge steepness are emitted.

For all 'on' switching instructions, the light path is only exposed when the aperture plunger is depressed, so that no unintentional instruction can be initiated, for example as a result of diode failure or on account of any other malfunction.

On application of the supply voltage, a momentary signal lasting a maximum of 50ms is present at the output. The electronic contact element has high reliability and long life as no mechanical or electrical wear takes place.

The unit is protected against extreme environmental conditions such as dust, corrosion and pronounced shock.

For more information, circle 249 on the Reader Services Coupon or contact Crusader Electronic Components, 73-81 Princes Highway, St Peters 2044; phone (02) 516 3855.

Australian toroids

Selectronic Components has installed a high speed, automatic toroid winding facility. It can now offer a wide range of coils with competitive costing and short lead times on large volume production runs. Prototyping and smaller production requirements can also be negotiated. The company can also provide mains power transformers, switch mode power supply inductors and transformers, and filter and switch inductors.

For more information, circle 243 on the Reader Services Coupon or contact Selectronic Components, 25 Holloway Drive, Bayswater 3153; phone (03) 762 4822.

New generation sub-rack

Bicc-Vero has launched its new subrack called the KM6-11. The new subrack complies fully with the IEC 297-3 and is the first of a series of new products to be released in coming months.

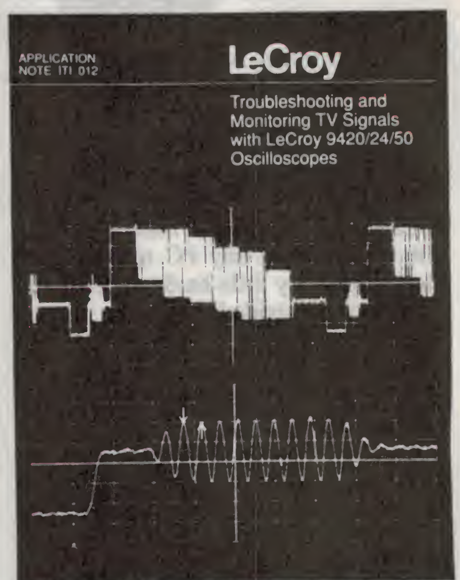
The KM6-11 offers the user the benefits of new features while remaining fully compatible with all existing accessories, front panels and plug-in units.

The new design has made the guides considerably easier to assemble and remove, and where required, they can be fixed more securely and rigidly.

The universal version of KM6-11 remains available in piece parts for special configurations, but a new benefit is that by using a simple, low-cost conversion kit, customers can convert the universal subrack into a high-performance EMC subrack when circumstances or conditions demand it.

For more information, circle 247 on the Reader Services Coupon or contact IRH Components, 32 Parramatta Rd, Lidcombe 2141; phone (02) 748 4066.

Troubleshooting TV signals



A new application note has been released by LeCroy regarding the advantages the 9420/24/50 oscilloscope series offers TV engineers.

These scopes are equipped with 8-bit ADCs, advanced triggering, signal processing and long 50K acquisition memories.

The advanced triggering techniques enable the user to trigger on PAL, SECAM, NTSC and HDTV signals. Up to 1500 lines and 8 colour fields can be selected.

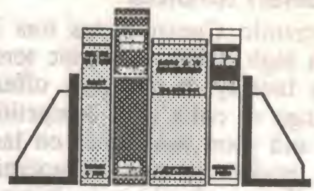
Automatic pulse parameter measurement and precision cursors are ideal for typical TV measurements, including colour-burst frequency, rise and fall times, white level, pulse width, horizontal and vertical blanking, line frequency, front and back porch time intervals and timing jitter.

With the addition of a firmware package (WP02) the scopes can also perform FFT spectrum analysis on incoming signals.

Cursors can be used directly on the spectrum to provide frequency, power, phase and magnitude readings.

For more information, circle 248 on the Reader Services Coupon or contact Scientific Devices, 2 Jacks Rd, South Oakleigh, 3167; phone (03) 579 3622.

NEW BOOKS



PC servicing

FIX YOUR OWN PC, by Robert McLaughlin, Susan Sasser and Mary Ralston. Published by MIS Press, 1990. Soft covers, 214 x 277mm, 255 pages. ISBN 1-55828-066-9. Recommended retail price $55.00.

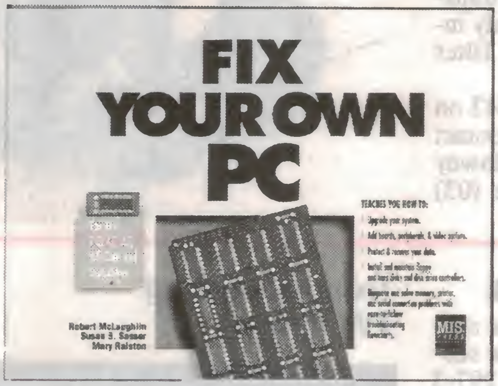
This is not a book for the service technician as such, but a 'do it yourself' guide for the reasonably intelligent and 'handy' PC owner/user. The aim is to show you how to fix many of the simple problems that often seem to plague PCs, so that you can avoid the cost and hassle of sending them away to the manufacturer's service workshop. Along with this it also covers things like fitting additional plug-in cards, disk drives and so on.

Author McLaughlin is an experienced software developer, with more than 10 years' experience in mainframe, mini and personal computers. Of his two co-authors, Susan Sasser is a professional computer technician who teaches PC troubleshooting and repair, while Mary Ralston is an award-winning technical writer with extensive experience in computer hardware. So they're all well qualified to write this kind of a book...

The book is divided into four main sections, headed '1: Diagnosing and Fixing Your PC'; '2: Data Pages'; '3: Troubleshooting Charts'; and '4: Appendices'. The first two sections and divided into 10 and five chapters respectively, with those of the first section dealing in turn with a rundown on the basic parts of a PC, using diagnostic programs, common problems and their solutions, maintaining floppy drives and hard disks, diagnosing memory problems, printer and serial port problems, upgrading your hardware, and data protection and recovery.

The chapters in section 2 then cover general basics such as elementary repair skills, system component identification and removal/replacement, the various video display and mass storage options, and how the various system components work (in basic terms).

Section 3 then provides some 15 troubleshooting charts, to assist in tracking down the exact cause of a large number



of possible faults. And finally the appendices of section 4 provide information on numeric, text and 'beep' error codes, standard I/O addresses, and a list of US suppliers. There's also a glossary.

The text is written in a friendly, down to earth style that should make it accessible to just about any PC user — even those with very little hardware familiarity. It's also provided with many illustrative photos, although some of these are rather dark and murky, and look as if they've suffered somewhat in the printing process.

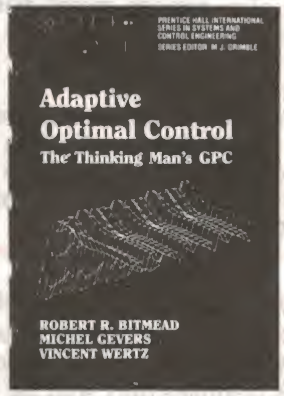
On the whole, though, my impression is that it should be of considerable value to PC owners and users, whether they want to tackle simple repairs or just need a bit of guidance when they're adding things like expansion boards or another disk drive.

The review copy came from the Australian distributor for MIS Press, Woodslane Pty Ltd, of 2/315 Barrenjoey Road, Newport 2106. However I've also seen copies in larger bookstores. (J.R.)

Control systems

ADAPTIVE OPTIMAL CONTROL, by Robert R. Bitmead, Michel Gevers and Vincent Wertz. Published by Prentice Hall of Australia, 1990. Hard covers, 243 x 177mm, 244 pages. ISBN 0-13-013277-2. Recommended retail price $55.00.

This is basically a book for the graduate EE student specialising in control systems, and the practising engineer who designs computer-controlled feedback control systems. The aim of the authors has apparently been to present a unified



approach to the design of such systems, linking currently popular applied methods such as generalised predictive control or 'GPC' with recent theory dealing with closed-loop adaptation and controller robustness.

The authors are all highly qualified specialists in this area. Bob Bitmead is Senior Fellow in the Department of Systems Engineering at ANU in Canberra, while Michel Gevers and Vincent Wertz are respectively Professor and FNRS Researcher at the Automatic Control Laboratory of the University of Louvain in Belgium.

It's quite a while since I had to plough through control system theory, I must confess. In those days it was largely just simple linear servomechanisms, with a bit of differentiation and integration thrown in to improve performance. Pretty archaic it was, by comparison with modern digital systems and their ability to adapt and 'tune' themselves for optimal performance. All the same, most of us found it pretty heavy going.

What this means is that I'm not really qualified to judge if this book is 'up to scratch', as far as its content is concerned. But we can probably assume that, given the qualifications of the authors. For what it's worth, it certainly seems to combine theoretical rigour with a clear exposition and friendly style.

In short, it seems likely to be a valuable up-to-date addition to the control system engineer's reference shelf.

The review copy came from Prentice Hall Australia, of 7 Grosvenor Place (PO Box 151), Brookvale 2100, but it should also be available from larger and technical bookstores. (J.R.) ■

THE ELECTRONIC COMPONENTS SHOP -

THE ELECTRONIC COMPONENTS SHOP

Information centre

Conducted by Peter Phillips

The right direction

This month I'm allocating more than the usual amount of space to one letter. This letter discusses conventional current flow versus electron flow, and makes so many good points that I've decided to include it all rather than offer a cut-down version. However there's still space for other items, including our usual What?? question...

There are many anomalies in life, with the reasons for their occurrence often buried in the mists of time. The English language is full of them, such as 'butch' versus 'clutch', 'look' as opposed to 'hoot' and so on.

Electronics has its own anomalies, but none so famous as the vexing problem of the 'real direction' of an electric current. Science has shown that because an electric current is really a flow of electrons, current flows from negative to positive. But convention, formulated before the electron was discovered, says the opposite.

Some say it doesn't matter, while others get quite hot under the collar in the defence of their preference.

An American text book on basic electricity can always be picked as the one containing wriggly lines for resistors and the use of electron flow. The Americans have Fleming's *Left* Hand Rule, while other countries have the Right Hand Rule with current flowing from positive to negative. Who's right? See what you think after reading the following letter...

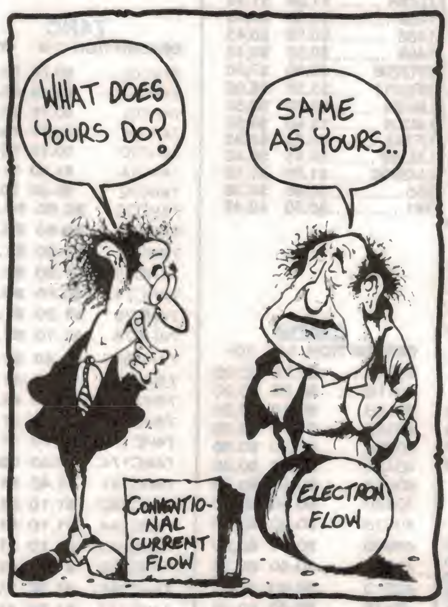
Current flow

So the old warhorse about direction of current flow has raised its head again in the December 1990 'Information Centre'.

This problem seems to occur with every crop of students, although it can usually be resolved fairly easily. Unfortunately many classes, and texts, are aimed at specific applications which do not allow the time or space to explain adequately the nature of an 'electric current' and the reasons for the adoption of a convention for the direction of current flow. As well, an explanation is often given at the beginning of a course, requiring more knowledge than a beginner usually has at that stage.

It is true, for practical explanations, that most of the current in metallic conductors is the result of movement of electrons from the more negative to the more positive potential. It should be noted however, that metallic conduction is only one of many types of conduction, and it is possible to have an electric current without a material conductor, such as the 'beam' in a cathode ray tube.

A second type of current is that in electrolytic solutions such as in copper or silver electroplating, where the current is the result of movement of positive copper or silver ions. In these cases the ions move from 'positive' to 'negative'. (Note that in some electrolytic solutions the current is by movement of negative ions, such as negative sulphate ions in a lead-acid battery, and these ions move in the same direction as electrons in metallic conductors.)



Another type of current is the discharge in ionised gases, such as a fluorescent tube where the description is complicated by the fact that it is usually operated on AC.

By considering only one half-cycle however, the situation is similar to DC. In this case the current is a result of movement of BOTH positive and negative ions, and there is an (almost) equal movement of charges in both directions.

There are many researchers who are interested in the composition of an electric current, but at the student level and in most practical applications the composition is only an explanation to help visualise what happens in a circuit. Of more importance is the RESULT of the current flow.

With DC, an electric current has three results, any or all of which may be the desired result.

1. *It generates heat.*
2. *It produces a magnetic field.*
3. *It causes a voltage to occur across a load.*

The first result is independent of the direction of movement or the polarity of the charges which constitute the current, but the second two are sensitive to both polarity and direction.

For example, an electron moving away from you would produce a magnetic field in an anti-clockwise direction around its path, but a positive ion

moving away from you would produce a magnetic field in a clockwise direction around its path. These results are reversed if the charged particles are moving toward you.

A general rule which can be deduced from this is that a stream of negative particles moving in one direction produces the same magnetic field direction as a stream of positive particles moving in the opposite direction.

The production of a voltage across a load can be illustrated by considering a 'load resistor' mounted horizontally. If the current is from a source of electrons at the right there will be more electrons on the right than on the left, making the left the more positive potential.

If the current is from a source of positive charges at the left, again the left will be at the more positive potential. In either case, negative charges from right to left or positive charges from left to right, will result in the more positive (or 'higher') potential on the left.

To determine the magnetic field around a gas discharge requires the flow of positive ions to be considered separately from the flow of negative ions (and subdivision of these flows into single-charged and double-charged ions).

This is clearly more awkward than simply considering one 'current', and one conventional direction for that current. Similarly, Kirchhoff's laws are easy to apply to ANY circuit to determine the current/voltage relationship and current direction in a particular branch. (Some people may dispute the 'easy' part, but how much more awkward would it be if positive and negative charge carriers had to be considered separately?)

Which direction is chosen for conventional current flow is therefore arbitrary, as in most cases the current is by a mixture of positive and negative charge carriers. (Current in a metal conductor also has a very small amount of positive ion migration, which is partly responsible for the failure of copper-iron water pipe junctions.)

Before the electron was discovered, current was assumed to flow from positive to negative, and numerous laws and rules were formulated such as Kirchhoff's laws and various right-hand and left-hand rules for determining the directions of magnetic fields, rotation of motors, and generation of currents. If the direction of 'conventional current flow' were to be changed, most of these rules would also have to be changed, causing confusion.

This confusion would serve no purpose, as the present system caters for current by both positive and negative charge carriers, and a change in the 'conventional' direction would still not conform to every form of current.

Had the opposite direction been chosen originally there would probably be exactly the same arguments proposed against that system as are proposed against the present system. (Lawrie Debnam, Elizabeth, SA).

Hmm! Food for thought in all that. It suggests something I'd never really thought of: current actually flows both ways, depending on the medium and the charge carrier.

In a semiconductor there are also positive and negative carriers, suggesting that picking either direction is just as suitable. So is the final answer simply 'there is no answer'?

Speaking of answers, here's a curious situation that is both annoying for the correspondent and interesting (I hope) to readers.

Tuneable hum

I have a hum problem! Not your garden variety hum, but tuneable hum. It comes in on the AM frequency of 891kHz on the ABC station 5AN, but nowhere else on the dial.

I am a serviceman of over 20 years experience and I thought I knew most of the tricks concerning earth loops and hum in equipment, but this one has me tricked. It occurs on three different receivers and has the following characteristics.

1. *It only occurs at 891kHz and is not even faintly audible on any other station or point on the dial, either AM or FM.*
2. *The level of the hum changes during the day without any pattern. Sometimes it is not even audible, other times it roars.*
3. *The hum occurs on a battery powered radio.*
4. *The level of the hum can be changed by moving the receiver horizontally with respect to the transmission, suggesting direction is a factor.*
5. *Other people living nearer to the station do not get the hum.*
6. *The hum is 50Hz.*

I live approximately 20km from the radio station, which has an output of 50kW and I've tried everything from removing earths to adding aerial loops. Does anyone have any ideas? (J.M., Aldinga Beach SA).

There are two questions I would ask you, J.M. The first concerns your assertion that the hum is 50Hz.

I conducted a few tests on typical speakers found in portable radios, and in all cases they could not reproduce a 50Hz tone. They were all quite loud at 100Hz, and it may be that the hum you are hearing is really 100Hz. Still, that doesn't help any, but my next question is whether the hum occurs when 5AN is off the air, as I don't think the problem is associated with 5AN.

While I don't claim any substantial experience on the subject, I recently had reception difficulties associated with the power lines in my street.

To try and trace the source of the interference, I donned a set of headphones and found I could get quite a high level of hum if I tuned the radio to the lower end of the AM dial and stood near a power pole which holds a 33kV to 415V distribution transformer. I found out later that this was due to the earth grid surrounding the pole.

This makes me think that you might be experiencing problems due to earth currents from the mains.

Perhaps your house straddles a seam of iron ore or coal, that is passing current or 'ducting' electromagnetic fields from nearby power poles. In any case, it seems like a problem associated with the mains, and one your local supply authority may be able to help with.

I had excellent co-operation from the supply authorities for my area, when I lodged a complaint through the Department of Communications and they went to no end of trouble. Unfortunately the problem was never fixed, but it wasn't for lack of trying!

INFORMATION CENTRE

Transformer ratings

While on the subject of power, several readers have sent me information on determining the VA rating of a transformer used with a rectifier circuit. This follows my discussion of this topic in the Basic Electronics series (Part 8, December 1990), and in the December 1990 Information Centre. Here's part of one letter...

I am writing in response to the item in the December Information Centre on transformer ratings. It seems that you have not quite got the whole story, which you acknowledge anyway. I think that the figures you give for secondary current rating are pretty close, though I feel you should be more conservative.

Using rough approximations, I feel the VA rating of the transformer should be at least 20% more than the expected maximum DC power. This means that for the usual full-wave bridge and capacitor arrangement the RMS current rating of the secondary should be at least 70% higher than the expected maximum DC current (1.7 x the DC load current).

Concerning the size of the filter capacitor, (Part 8 of Basic Electronics) you suggested starting at 1000uF and adding 1000uF for each additional amp. I think that a more realistic rule is to use 3000uF for each amp of current.

This will give approximately 3V of ripple at full current, assuming a full wave rectifier. This rule seems to work over a wide range of currents for power supplies I have made, although the limitation is whether the transformer and rectifiers can take the high peak currents involved.

Incidentally, you suggest that peak currents of five times the load current are typical in a full wave rectifier. I reckon they are 10 to 20 times greater. (P.D., University of Sydney).

But P.D. also has more to say, in a second letter that arrived the day after the first:

It seems my suggested multiplier of 1.7 for determining the current rating for the secondary of a transformer used in a power supply is too low. After writing, I lashed up a power supply (centre-tapped, dual polarity) using a 100VA toroidal transformer with two 10,000uF filter capacitors, one each per leg.

And the results? I measured 112VA in for 80W of DC power out. The transformer got extremely hot, reaching 60 degrees in an air conditioned lab. Halving the values of the filter capacitors made no difference.

From this, it seems the 1.7 factor I previously suggested should be increased to 2.0. That is, a 1 amp DC supply should have a transformer rated at 2A RMS (secondary).

Included with the first letter was an extract from a National Semiconductor Voltage Regulator Handbook, which I studied carefully to see what National reckon.

The mathematical approach used was far from easy to understand and as far as I can figure, the secondary current rating is found by using a form factor taken from a graph and then applying it to one of three possible equations, depending on the rectifier circuit.

I found it impossible to figure out how to get the form factor, so I gave up on that one. Testimony to my assertion that power supply design is complex!

The next letter on the topic was in the form of a proposed article (which we are thinking of printing) and included three pages of tables containing a wealth of information.

From one of these tables, the correspondent (R.G., of Wollongong NSW) reckons the transformer VA rating should be 1.11 times the DC output power (bridge rectifier, capacitor filter), and the secondary current will be 1.57 times the DC current.

These values are lower than my figure (1.66) and lower than the 1.7 (revised to 2) given by the first correspondent. I just wish I could calculate the figures National reckon on. So all in all, the best suggestion seems to be the more conservative the rating, the better!

Electrolytic caps

Following the discussion of electrolytic capacitors in the November (1990) edition, I've received some excellent technical papers from Ericsson Components, who market the RIFA brand of components.

You might recall that the discussion concerned operating an electrolytic capacitor at a voltage less than its rated value, and the effects this might have on the capacitance value.

While the literature from Ericsson doesn't specifically refer to this, it's fairly obvious that it is not an issue. Here's an extract from one of the papers, which I'm sure you will find interesting...

The rather unexciting appearance of wet aluminium electrolytic capacitors hides quite an interesting functional principle, based on the properties of aluminium oxide in combination with a liquid electrolyte.

In aluminium electrolytic capacitors the dielectric is a thin layer of aluminium oxide formed on the positive electrode, the anode foil surface. This oxide has rectifying properties and can withstand a voltage of one polarity only.

The capacitor is therefore normally a polarised device, although in non-polarised designs, both electrodes have an aluminium oxide layer of equal thickness.

Using an etching process, the aluminium anode foil surface is eroded, creating a very rough profile and resulting in a vastly increased effective surface area compared to the original plain foil surface.

Aluminium oxide is applied on the rough surface by an electrochemical process, called the forming process, where a constant voltage is used.

The oxide thickness is approximately proportional to the forming voltage used, and to a large extent, the oxide thickness will determine the capacitor's voltage handling capability. In practical terms, a 63V, 10,000uF capacitor will have an oxide thickness of about 100nm and a surface area of 10 square metres.

The electrolyte acts as an extension of the negative foil and is retained with a porous paper layer that also acts as a spacer between the two foils. The

electrolyte is highly conductive by means of negative ions.

The paper includes a lot more information, including details of how electrolytic capacitors are self-healing and a discussion on the disadvantages of electrolytes based on glycol. It also makes the point that the capacitance (and the leakage current) of an electrolytic increase with temperature.

But the clincher, as far as I can see, is that a wet aluminium capacitor has an 'infinite shelf life without the need to reform.' In other words, the oxide layer thickness (and therefore capacitance value) is formed during manufacture, and that's it. Our thanks to RIFA and Ericsson for this information.

What??

It's black box time. I have a black box with two terminals connected to a device inside the box. Using a moving coil multimeter as an ohmmeter, I measure 15 ohms across the terminals when the meter is set to its x1 range. When the x10 range is selected, the resistance is 4 ohms. No, it's not a diode, as it doesn't matter what polarity I use. What's inside the box?

Answer to last month's What??

You either twigged fairly quickly or gave up in disgust, on last month's What?? The solution is to use a two-input AND gate (A.B) and a two-input OR gate (C+D), with their outputs joined together. Oh yes, they need to be open collector types, of course! ■

TV CRO Adaptor

Continued from page 90

width of lines 2 and 4, and that VR4 adjusts the remaining lines. A vertical trace may also appear in the centre of the screen, which will disappear when VR3 is adjusted. These lines will not move when VR5 is adjusted, as they are independent of this control.

The final test that can be performed is to check that the sweep frequencies are correct. Connect a frequency counter (or a 'scope) to the centre terminal of SW2, which eventually supplies the 'store clock' to PC board 3. Frequencies ranging from 30.5Hz to 12MHz should be measured at this point, depending on the settings of SW1 and SW2. You might also like to confirm that the signal referred to as 'gated 3MHz' is present at pin 6 IC8. This signal will appear as an 8ms wide burst of 3MHz, spaced midway between the vertical sync pulses. The relevant waveforms for this board are shown on the circuit diagram, in case you need to do some fault finding.

This is all that can be done now. In the next of these articles we'll present the vertical amplifier and graticule generator section, which can then be combined with this board for further tests. ■

Construction Project:

A NEW 2M FM TRANSCEIVER - 3

Last month, we covered the assembly of the main PC boards for the project, the construction of the shield boxes, and the assembly and testing of the power supply, CPU/display and VCO/PLL sections of the circuit. Here we deal with three more sections, which when wired and tested result in the 'receive' side of the unit being complete and operational.

by JIM ROWE

Hopefully by now you will have assembled all of the circuit sections we covered last month, and put them through their paces as described, to check that they're working correctly. Even if there were a few problems, you should have been able to remedy matters by taking advantage of the troubleshooting information we provided.

The same kind of section-by-section treatment will be used for the remaining sections of the new design, with each section covered by testing and troubleshooting information in addition to the basic assembly description. This should ensure that you can complete all sections and get the transceiver going successfully.

This month we cover the next three functional sections of the circuit: the receiver section audio and IF amplifiers, and the low-level RF section containing the 'receive' RF stage and mixer, the VCO amplifier stages and the transmit driver stage. When you complete these sections and fire them up, the 'receive' side of your transceiver will be virtually complete, and you should be able to connect it up to an antenna and listen into the 2-metre band.

I should perhaps warn you that there's a fair bit of wiring involved in these three sections, and that with quite a lot of components mounted in a reasonably dense fashion, it all takes time.

As I suggested previously, this is *not* a project for the inexperienced beginner, or for those who like to be able to 'knock it together' in a single evening! However if you proceed steadily and exercise a reasonable amount of care, you should be greeted by the sounds of a functioning receiver, after only three or four evenings...

Let's get going, then, with the next section in the sequence.

6. AF AMPLIFIER

Before we proceed, I should advise you of an error that has been discovered in the main PCB overlay diagram for the transceiver, given in the February article on page 95. It's an error that directly concerns the audio amplifier section, which you're about to assemble — and as with the other sections, you'll be using this diagram as your main guide in placing and orientating the components. So now's the logical time to correct your diagram, before it leads you astray.

The error is simple: transistors Q103 and Q104 were transposed, on the diagram. Q103 is in fact located between C105 and R109, while Q104 is between R110 and R112, near the right- hand edge of the board.

I suggest that you modify your diagram to correct this error *right now*, before you forget. If you inadvertently fit the two transistors in the transposed positions originally shown, and apply power, both transistors are likely to be destroyed — along with Q105 and R109. I write from personal experience!

The audio amplifier circuitry is located near the front of the right-hand side of the main board, as you will have gathered. The only exception is the 'receive' volume control pot R101, which mounts on the display board at the top of the left-hand end. More about the pot later — for the moment it can be put aside, while we concentrate on the other components. These are all identified by a '1XX' number.

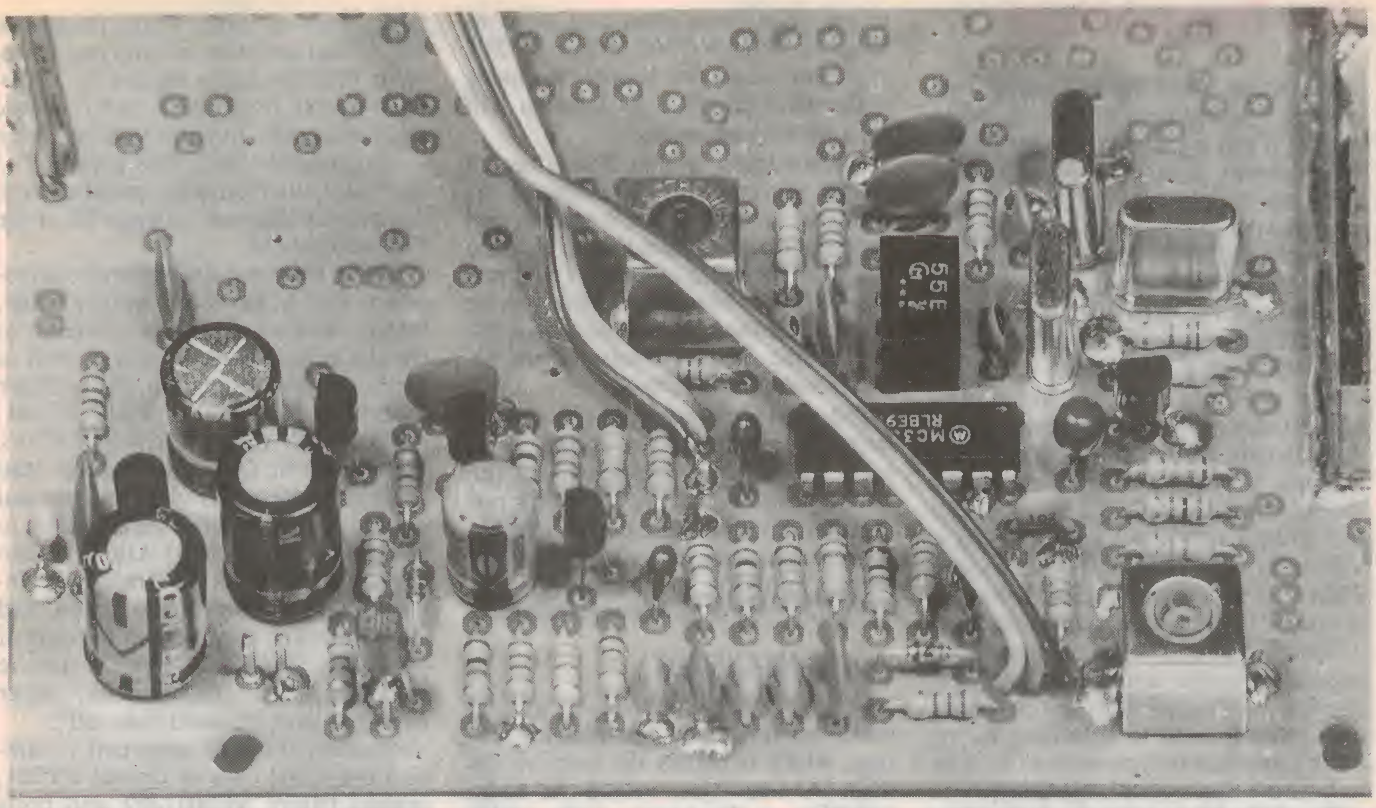
Incidentally the schematic for the audio amplifier section was shown in Fig.8 of the January article, if you need to refer to it during the assembly or testing.

There are a relatively small number of components involved in this section, so it won't take long. As usual it's a good idea to start with the low-profile resistors and diode first, then fit the smaller capacitors, followed by the larger electrolytics and finally the transistors. Take care with the orientation of these last-named groups, of course.

Note that while it probably isn't essential to solder the pigtails of the 'earthed ends' of C104, C108, C109

PARTS LIST 4: Audio amplifier

Qty	Description	Location
2	2.2 ohm 1/4W	R110, R111
1	15 ohm 1/4W	R109
2	220 ohm 1/4W	R107, R113
1	1k 1/4W	R112
2	2.2k 1/4W	R102, R105
1	3.3k 1/4W	R106
1	10k 1/4W	R108
1	33k 1/4W	R104
1	56k 1/4W	R103
1	5k log sw. pot	R101
1	1nF ceramic	C109
3	0.1uF ceramic	C103, C104, C108
1	1uF 16V tant.	C101
1	220uF 16V elec.	C102
2	330uF 16V elec.	C106, C107
1	470uF 16V elec.	C105
1	1N4148	D101
1	BC548	Q101
1	BC558	Q102
2	BC338	Q103, Q105
1	BC328	Q104
2	PCB pins	
1	20cm length audio coax	



Here's a shot of the next two sections — the audio amp and IF amp/demodulator, which are both positioned along the right-hand side of the main PC board. The audio amp is on the left, here, with the IF section to the right. Use this picture and the overlay diagram given on page 95 of the February article as a guide, when you're wiring these sections.

and R107 to the top ground plane copper as well as the underside copper tracks, there's no harm in doing so. It might even help ensure that the AF amp operates a little more reliably, with greater immunity to stray RF. The same applies to the collector lead of Q104. Just make sure, if you do decide to solder these leads to the top copper, that you don't overheat the components in the process.

A couple of PCB terminal pins should be used for the speaker connections, to allow the lead from the speaker to be connected and disconnected easily. Again the 'earthed' pin should be soldered on the top side of the board as well as the bottom.

At this stage, your audio amplifier section should almost be ready for testing. The one remaining step is to mount the volume control pot R101 on the display board, at the top of the left-hand end. At this stage it isn't wired up, however. R213 the squelch control pot can also be mounted at the same time, in the adjacent hole.

The volume pot should be mounted with its three main lugs uppermost, while the squelch pot should be mounted with its main lugs at the bottom. This allows the two locating spigots to mate with a pair of 3mm holes, drilled in the display board between the two main pot mounting holes and along the line between them, so that neither pot will tend to rotate in use. (R213 can't be mounted with its lugs uppermost, as its spigot would conflict with the display board support bracket).

The display board for the unit I assembled didn't have these locating holes drilled, but it was a simple matter to drill them, after using one of the pots to determine the correct location — using its spigot as a crude marking scriber, with the pot rotated manually in the mounting holes.

Note that both pots have integral switches, with lugs which protrude from the sides. To ensure that these lugs don't touch either each other or the display board mounting bracket, it's necessary to bend them inwards by about 90°. This can be seen in one of the photographs.

Testing the amp

1. Join the ON-OFF switch wires together, if they aren't already joined; also connect the speaker to the speaker connection pins, via a length of two-wire rainbow cable about 250mm long. Then connect 13.8V DC power to the unit.

2. By pressing any of the display board keys you should be able to hear a 2kHz 'beep' from the speaker, with a duration of a few hundred milliseconds.

3. Apply an audio signal from an audio generator to the input of the amplifier. The 'hot' input is the centre of the three PCB pads which will ultimately connect to R101, while the pad to its right (nearer to C101) is the earthy input. About 200mV RMS input should result in the rated output of 1W into 8 ohms. But if you do not have an audio generator, simply touch one end of R102 with your finger. You should hear the typical (not very loud) amplifier hum from the speaker when you do this.

Troubleshooting

In the (unlikely) event that your amplifier doesn't seem to be working correctly, here is the relevant information to assist in troubleshooting.

1. Check the following DC voltages:

Q105	collector	13.8V
	base	13.8V
	emitter	13.1V
Q101	collector	12.5V
	base	8.2V
	emitter	7.6V
Q102	collector	6.8V
	base	12.5V
Q103	base	6.8V
	emitter	6.3V
Q104	base	6.0V
	emitter	6.5V

2. Assuming all of the DC voltages are correct, you will need to trace the progress of a test signal through the amplifier, ideally using an oscilloscope (although this is not essential). If you don't have an audio generator to provide the test signal, you can use almost any audio equipment, such as a radio or tape recorder, with an external output capable of providing a signal of around 200mV.

If such a source only has a speaker output, you may need to make a voltage divider with two resistors, to reduce the signal to around 200mV. For example if you have a cassette player capable of delivering 1W into 8 ohms, this will provide about 2.8V RMS ($E = \sqrt{(P \times R)}$). To reduce this to around 200mV, you'll need to divide this by about 13:1. We would suggest using a 330-ohm and a 27-ohm resistor, connected in series across the player's speaker — or preferably across an 8-ohm resistor used to substitute for it, during the tests (if you want to be able to hear the transceiver's speaker!).

The 200mV test signal will be produced across the 27-ohm resistor — but it will be advisable to connect a 0.1uF capacitor in series with the 'hot' side, if you're going to be injecting it into the various stages of the amplifier. This will prevent the 27-ohm resistor from disturbing the amplifier's DC circuit conditions.

If you have a 'scope, you can connect the audio test signal to the transceiver amplifier's input and trace its progress through Q101, Q102, Q103/4 and so on, using the 'scope. Obviously if there's a problem, its location will soon become apparent.

Alternatively if you don't have a 'scope, you can work in reverse by listening to the transceiver's speaker and applying the test signal first to the base of Q104, then that of Q103, Q102 and finally Q101. Not only should you be able to hear the signal in each case, but the volume should increase as you inject it earlier in the chain.

The most likely cause of any trouble with the amplifier is a wiring error, such as fitting a component in the wrong position or with the wrong orientation. So if you take care with these aspects and check everything carefully before applying the power, it's unlikely that you'll have any problems.

7. IF AMPLIFIER

Now you should be ready to wire up the IF amplifier and demodulator section, which occupies the area on the main PC board just behind the audio amplifier at the centre of the right-hand end. The circuit schematic for this section was shown in Fig.7 of the January article, while its components are identified with a '2XX' number.

As before, it's best to start with the low-profile resistors and capacitors, work up to the larger and taller components and finally fit transistor Q201 and IC U201.

Take care again with the polarised parts, such as diode D201 (alongside R215) and tantalum electrolytic C216. Note that the latter should be orientated so that its positive lead is on the right-hand side, looking from the front — i.e., nearer C202. The polarity '+' sign was inadvertently omitted from the overlay diagram on page 95 of the February article.

Again, there are a number of components which have an 'earthy' side, where the lead should be soldered to the top ground-plane copper as well as to the copper under the PCB. These include R201, R211, R212, C201, C203, C208, C212, C214 and C216. When you fit Q201, its emitter lead should also be soldered to both top and bottom copper, and the same applies to pin 15 of IC U201. All of these ground-plane joints are virtually essential for this section of the circuit, and not optional as they were in the case of the audio amplifier. Here, if they're not done the IF amplifier may either have low gain, or could 'take off'.

Similarly it's also important to connect the metal case of crystal XT201, crystal filters XF201/202 and coils L201/202 to the ground plane, with a small solder joint at one end (or both ends for L201/202). As before take care to achieve good electrical bond to the ground-plane copper, with proper solder 'wetting', but without overheating the components concerned.

If you are using only one crystal filter, then bypass the second crystal filter position with a wire link (input to output) and leave out capacitor C201 (6.8pF).

The wiring to connect pots R101 and R213 to the indicated board points should now be fitted, using a section of rainbow cable initially about 300mm long and with six wires. Three are used to connect R101 to the pads between C207 and R102, while the other three connect R213 to the pads just in front of L201.

Keep all six wires together for the main length of their run, separating them into the two separate groups at either end and chopping them to the correct length as shown in the photo. This makes for a neater job. Note again that the wire from the 'earthy' (fully-anticlockwise) end of R101 connects to the pad nearest R211, and is soldered to the top ground plane copper as well as to the underside.

Incidentally at this stage, the transceiver ON/OFF wires can also be connected to the switch contacts at the rear of R101, so that the switch can become operational.

PARTS LIST 5: IF Amplifier

Qty	Description	Location
2	100 ohm 1/4W	R205, R206
1	470 ohm 1/4W	R212
1	1k 1/4W	R208
1	1.5k 1/4W	R211
3	2.2k 1/4W	R215, R217, R219
1	3.9k 1/4W	R202
1	6.8k 1/4W	R201
1	10k 1/4W	R216
1	15k 1/4W	R210
1	33k 1/4W	R214
2	47k 1/4W	R204, R220
1	68k 1/4W	R203
2	82k 1/4W	R207, R218
1	270k 1/4W	R209
1	5k log sw. pot	R213
1	6.8pF ceramic	C201*
1	10pF ceramic	C209
2	33pF ceramic	C213, C217
1	150pF ceramic	C212
3	1nF ceramic	C202, C205, C206
2	10nF ceramic	C208, C214
4	0.1uF ceramic	C204, C210, C211, C215
2	1uF 16V tant.	C203, C207
1	33uF 10V tant.	C216
1	1N4148	D201
1	2SC1923	Q201
1	MC3357	U201
1	10.245MHz Xtal	XT201
1	10.7MHz filter	XF201
1	10.7MHz filter	XF202*
1	455kHz filter (CFW455F or G)	CF201
1	Coil, '10MA'	L201
1	Coil, 455kHz	L202

* Optional. There are three possible ways of connecting crystal filters. Most manufacturers of 10.7MHz quartz filters make either single-pole or double-pole filters, inside one HC18 package. The minimum requirement here is one double-pole or two single-pole filters. Using two double-pole filters will improve the rejection of signals 910kHz below the receiving frequency.

Testing the IF

Here are the steps for checking the operation of the completed IF amplifier and demodulator section:

1. Connect the speaker and 13.8V DC power supply, and switch on.
2. Adjust the volume to midway and then turn up the squelch pot R213. At a particular point this pot should act like a noise switch, turning the IF amplifier's noise on and off as heard in the speaker. This shows that the squelch gating circuitry is working.
3. Open the squelch (noise audible) and adjust L202 for a null in the noise level, with minimum high-frequency content. Either side of this null the noise should increase, and become more harsh.
4. If you have an FM signal generator, adjust it for an output at 10.700MHz but with no modulation. Then connect its output to the input of the IF amplifier, at the pad of crystal filter XF201 nearest the VCO/PLL shield box. Adjusting L201 and L202 should allow you to achieve about 12dB of quieting for around 3uV of input, if everything is operating as it should be. That is, the audio noise output should drop by 12dB when the generator output is switched on and set for about 3uV, compared with the noise level when it is switched off.

Note that if the squelch gate closes during your adjustments, R213 should be turned to open it again.

Switching on the generator's modulation, with the deviation set for 3.5kHz, should produce a sinewave audio output. L202 should be adjusted for the largest undistorted output, judged either by ear or by observation with the 'scope.

Note that the tuning of L201 will appear to be very broad, due to the way the limiter operates. The best way to adjust this coil is to gauge its effect on the squelch 'switching' threshold, as set by R213.

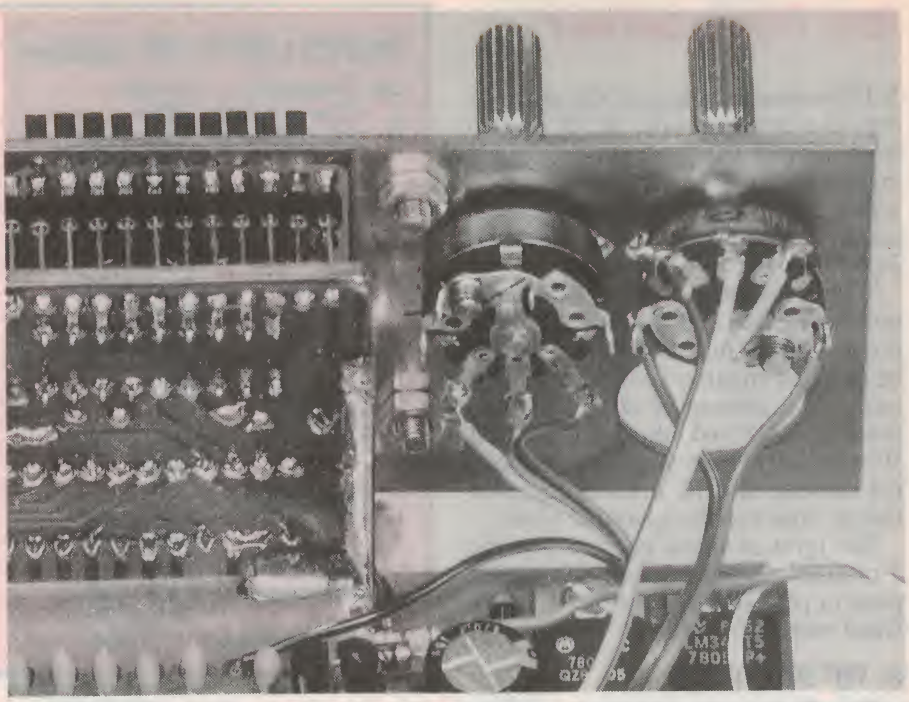
That's about all you can do at this stage. Final adjustments can be done when assembly of the transceiver is nearer completion.

Troubleshooting

If you weren't able to carry out the foregoing tests satisfactorily, here is the information to assist in troubleshooting.

1. Measure the following DC voltages:

IC 201 pin 1	7.0V
2	6.5V
3	7.0V
4	7.2V
5	1.2V
6	1.2V
7	1.5V
8	7.0V
10	2.2V
13	6.5V
15	0V
16	2.2V
Q201 base	0.6V
collector	7.0V



Here is a close-up of the volume control and squelch pots, mounted on the end of the display board. Note the switch lugs are bent, to prevent them touching.

2. If there is an absence of noise output, for any position of R213, this might be caused by three main things. There may be a problem with the squelch or the discriminator, or a faulty or low gain IF preamp (Q201). Alternatively there could be a problem with the 10.7/455 mixer inside U201.
3. If the squelch doesn't seem to be operating, try varying R213 and measure the DC voltage on pin 12 of IC201. This should change from about 300mV to 1.1V. The squelch threshold is at about 0.8 volts. If the voltage on this pin is higher, the mute switch (U201 pin 14) will be open and the signal or noise should be going to the audio amplifier.

If there is a problem where the noise is present and cannot be gated off using the squelch control, then this is probably related to a fault with one of the components connected to U201 pins 10, 11, 12 and 14.

4. The FM discriminator and limiting amplifier can be tested by connecting a signal generator to the input or output of the ceramic filter (pins 3 or 5 of U201). By adjusting coil L202, the DC level on pin 9 should change between 800mV and 6V volts. If the generator is being modulated, you might be able to see with a 'scope the audio signal on this pin superimposed on the IF (455kHz) signal. This is filtered out by the R216 and C208 low pass filter. Any malfunction in this area could be caused by the circuitry around U201 pins 6, 7 and 8. →

5. If the sensitivity is poor, this could be due to a problem with the IF preamp stage around Q201, or the IF second mixer (10.7MHz/455kHz) section within U201. A problem with the latter is usually caused by an incorrect level injected from the crystal oscillator.

Within-tolerance variations in the internal impedance of the crystal XT201 might require that the value of C213 be changed slightly. To try this, temporarily fit a trimcap of about 60pF instead of C213 and adjust this for best IF sensitivity. Then switch off, remove the trimcap and fit a fixed capacitor that is closest to the measured value.

The level of signal injected into pin 2 of U201 should be about 50-100mV peak to peak (measured using a 'scope fitted with a 10:1 probe).

PARTS LIST 6: RF section

Qty	Description	Location
1	47 ohm 1/4W	R303
11	100 ohm 1/4W	R304, R305, R308, R310, R313, R314, R315, R317, R318, R322, R324
3	1k 1/4W	R319, R320, R321
4	2.2k 1/4W	R302, R312, R316, R323
1	3.9k 1/4W	R301
1	10k 1/4W	R311
3	47k 1/4W	R306, R307, R309
1	10pF ceramic	C320
4	15pF ceramic	C305, C307, C309, C311
1	18pF ceramic	C335
4	22pF ceramic	C313, C329, C330, C333
1	33pF ceramic	C324
15	1nF ceramic	C303, C304, C314, C316, C317, C319, C321, C322, C325, C326, C327, C332, C334, C337, C338
2	10nF ceramic	C315, C318
1	60pF trimcap	C301
9	20pF trimcap	C302, C306, C308, C310, C312, C323, C328, C331, C336
2	1N4148 diode	D301, D302
2	MI301 diode	D303, D304
2	BF981 MOSFET	Q301, Q302
2	2SC1923	Q303, Q304
1	2SC2407	Q305
1	Coil, '10MA'	L307
3	PCB pins	
	1m length of 0.8mm enamelled wire	

8. RF SECTION

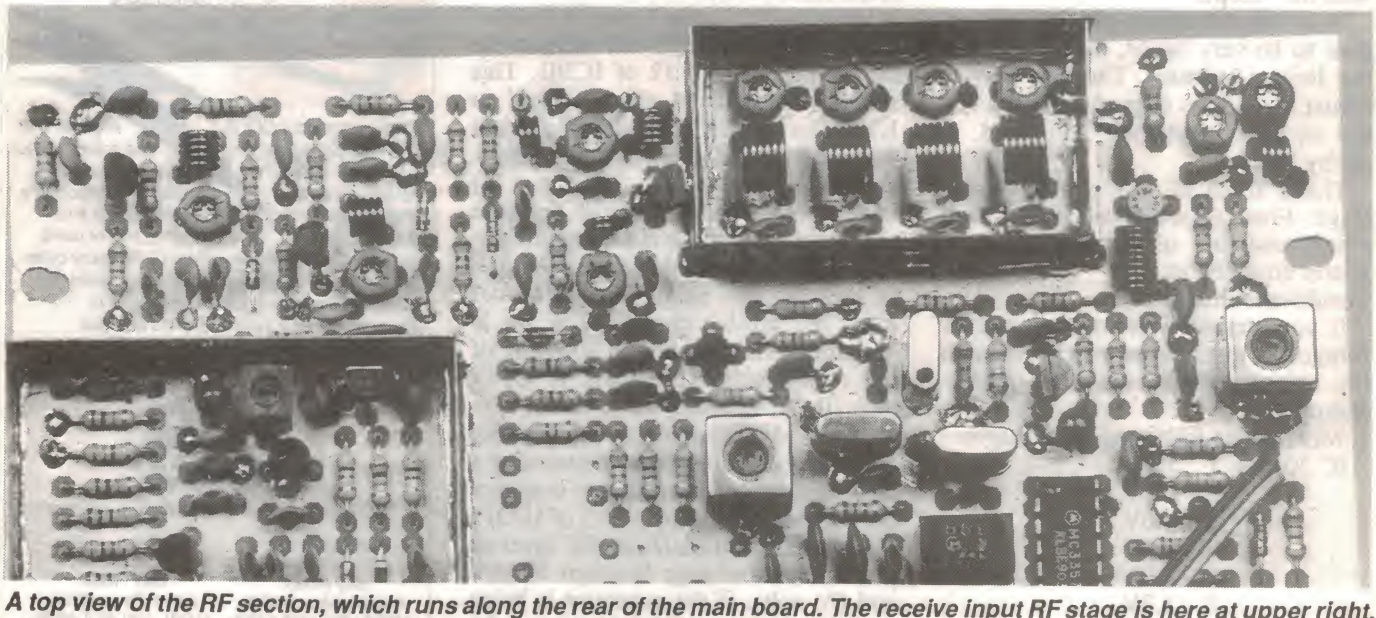
The final section required to complete the basic 'receive' side of the transceiver (and the 'transmit' RF driver circuitry) is the low-level RF section, and this is the next to assemble and test.

The schematic for this section was shown in Fig.6 of the January article, while its components are all identified with '3XX' numbers. Basically it occupies the rearmost 50mm or so of the main board, and across the full width.

As before it's best to start with the low profile components such as the resistors and diodes — making sure that the latter are placed in the correct positions and with the right orientation. Note that biasing diodes D301/302 are type 1N4148 (or 1N914), while the RF switching diodes D303/304 are type MI301. The latter are usually marked 'MI1', while the 1N4148/1N914 sometimes have no marking except a black band to indicate the cathode. (The MC301 diode used for D402 in the VCO section is generally marked 'MC1', by the way.)

The capacitors should be added next. As before many of the ceramics need to have their 'earthy' pigtail soldered to the copper ground-plane on the top of the PCB, as well as to the underside. You'll need to carefully remove the ceramic on the chosen pigtail, by gently crushing it with pliers and then scraping back to the body with a hobby knife. This allows the component to be mounted close to the board, with minimal length leads, but still permits you to make a soldered joint to the groundplane. The capacitors involved are C303, C304, C305, C307, C309, C311, C312, C314, C315, C316, C317, C318, C319, C321, C322, C324, C325, C326, C327, C329, C332, C333, C334, C335, C337 and C338.

Many of the trimmer capacitors also have one side grounded, and those in this category also need to have this side soldered to the top ground plane copper as well as underneath. This ap-



A top view of the RF section, which runs along the rear of the main board. The receive input RF stage is here at upper right, with the bandpass filter box to its left and the transmit RF driver stages further left again. The VCO shield box is visible at lower left, and the IF stage at lower right. Note the orientation of the trimmer caps and coils.

plies to C302, C306, C308, C310, C312 and C331. Note that with each of these trimmers (all 20pF max), it is the exposed lead at the *rounded* end that should be earthed. This is really the only practical way to do it (the other lead is inaccessible), and it also ensures that the trimmer can be adjusted with a metal- bladed alignment tool without disturbing its operation.

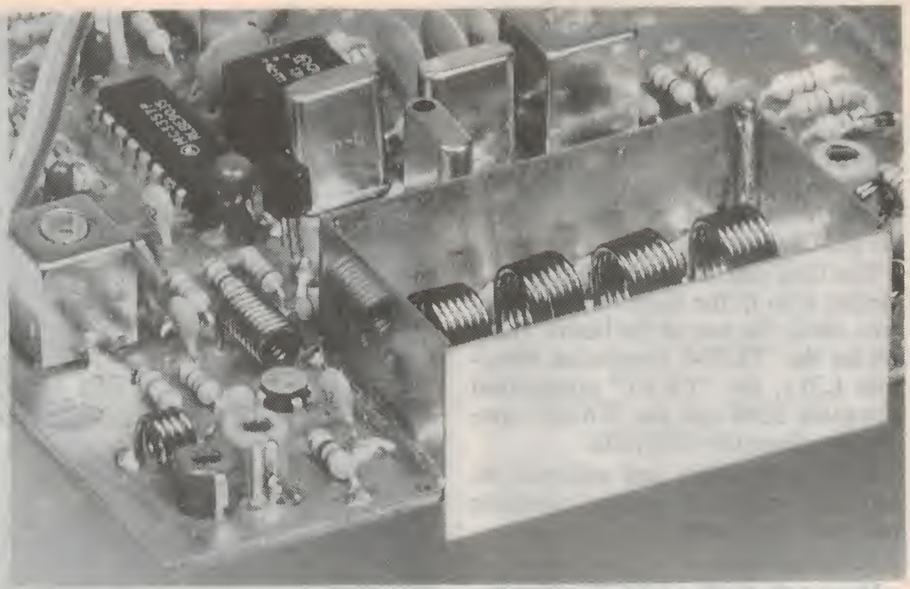
Note that four each of the affected ceramics and trimmers are inside the rear 'filter' shield box. This makes the job of soldering their earthy sides to the ground plane rather awkward, but it can be done. You just have to be especially careful not to damage the components in the process.

The remaining trimmers have neither side earthed, and so can be fitted either way around. Note that C301 is the odd one out — a 60pF maximum type, with a brown body instead of the red body used for the 20pF trimmers.

The transistors can now be fitted, again taking care to fit the right one in each position and that they're the correct way around. Note that Q304 and Q305 both have their emitter leads soldered to the top ground plane — with Q304 this is the lead nearest C401, while with Q305 it's the centre lead. Again, take care not to overheat the components when making these ground- plane connections.

Note that Q304-306 are mounted with their bodies about 4mm from the board.

Take special care when you're fitting the two MOSFETs, Q301 and Q302. These are both the BF981 device, which is in a mini 'pill' package with four leads coming out of the sides. These need to be bent carefully at right angles, close to the body, so that they can mate with the PCB holes. But note that in the case of Q301, the leads are bent *down* with the 'label' side facing you, while with Q302 they must be bent *up*. This is because Q301 mounts on the board with its label side uppermost, while Q302 mounts with its label side down towards the board. Both of these transistors mount right down against the board.



A close-up of the receive input RF stage, to guide you further during assembly.

How can you tell the correct orientation for Q301/302? Easy — the drain lead is the longest of the four, and both drains go towards the front of the main board. So the drain of Q301 is the one nearest L302, while that for Q302 is the one nearest R307.

Now you should be ready to wind and fit the coils. These are all wound using 0.8mm enamelled wire (#20 B&S, or #21 SWG). The number of turns, direction of winding and former diameter used for each coil are shown in the table.

Take special care when winding the coils, as the single most common cause of trouble with previous transceivers and similar RF projects has been mistakes in coil winding. Use the shank of a 1/4" drillbit as a former for L303-306, and that of a 1/8" drill for the rest. It is very important to use the *exact* diameter (i.e., a 1/8" drill, not 3mm or 3.5mm).

Similarly all coils should be *close wound* — i.e., the turns must be wound tight against each other. You'll find it a lot easier to do this if the wire has been 'stretched' slightly, before winding. I do this by cutting off a length about a metre long at a time, clamping one end in a vyce and gripping the other with a pair of stout pliers. I then pull until the wire stretches a bit — making it both straight and stiff for convenient close winding.

To clarify the winding terminology, the description '3-1/2 turns' means that the coil has three whole turns, from the start point to the end, and then a further half turn, so that the legs of the coil both face in the same direction. So if you count the number of turns of such a coil from the top, there should be four, but from the bottom there will appear to be three.

Don't forget to follow the specification for the direction of winding — note that L302 is wound in a clockwise direction, while the rest are wound anticlockwise. This is important if the coil legs are to mate with the corresponding PCB holes, with each coil aligned in the correct direction as shown on the overlay diagram (and visible in the photos).

It's a good idea to scrape the enamel insulation from the legs of each coil with a hobby knife, after it is wound and while it is still on the shank of the drillbit former. This avoids distorting the shape, but makes the coil ready for soldering into the PC board.

The coils for the bandpass filter (L303-306) should sit about 4- 5mm above the board, so that their axes will be roughly midway between the PCB and the lid of the shield box when it is fitted. All of the other coils should sit closer to the board — roughly 1mm or so above it. →

COIL WINDING DATA

No. of turns:	Former diameter:	Winding direction:	Locations on PCB:
5-1/2	1/4"	ccw	L303, L304, L305, L306
1-1/2	1/8"	ccw	L310
2-1/2	1/8"	ccw	L312
3-1/2	1/8"	ccw	L301
4-1/2	1/8"	ccw	L308, L309, L311
8-1/2	1/8"	cw	L302

All coils are wound with 0.8mm diameter enamelled wire (#20 B&S, #21 SWG).

2m Transceiver

Only one coil has an earthed end, which needs to be soldered to the PCB ground plane. This is L301, and you'll need to scrape back one of its legs further than for the other coils, to allow the joint to be made.

The final step in assembling the RF section is to fit the three PCB terminal pins, along the rear of the board. These are for the 'TX12V' connection alongside L311, the 'TX-RF' connection alongside L312 and the 'RX-RF' connection alongside C301/302.

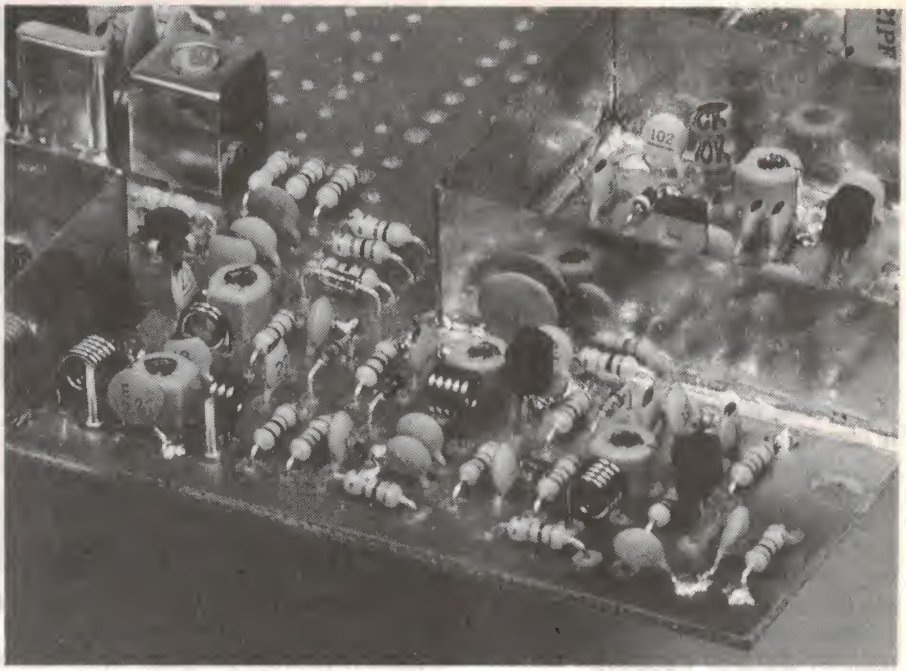
With these fitted and soldered in, your RF section should be complete and ready for testing.

Testing, testing...

Here is the testing procedure for this section of the circuit:

1. Reconnect the speaker and the 13.8V DC supply, and if possible connect a signal generator tuned to 147.000MHz to the RX-RF input (earthy side to the ground plane). If you don't have access to a signal generator, connect a 2-metre antenna instead. Then check that the 'PTT' pin near the front of the main PCB is disconnected from ground (so that the transceiver will be in 'receive' mode), and turn on the power.

2. If you're using a generator, check that the transceiver display indicates '7000', showing that it is tuned to 147MHz. Otherwise tune the transceiver onto a strong local signal (e.g., a local repeater, or a second transmitter that is transmitting into a dummy load. The leakage from such a load is usually enough to produce a suitable signal level).



Another view of the RF amplifier and transmit driver stages, to help in assembly.

3. Now proceed to adjust all the trimcaps except C331 and C336, as well L307, for maximum 'receive' sensitivity (best signal to noise ratio). Note that at this stage, the maximum sensitivity for 12dB of quieting will be only around 1uV (about 0.3-0.4uV for 12dB SINAD), due to the incorrect matching of the direct input to the RX-RF pin.

4. If all seems well, turn off the power and disconnect the generator or antenna from the RX-RF transmitter input.

5. Now connect a sensitive wattmeter, or SWR meter that is able to indicate RF power level in 100's of milliwatts, with a 50-ohm load, between the TX-RF output pin and ground. If you don't have either of these instruments, connect a small 2-6 volt (0.1-0.3W) lamp.

6. Temporarily connect the TX12V pin to the +13.8V supply rail at the transceiver side of the on-off switch (on R101), and connect the PTT pin to the ground plane. Then re-apply the power.

7. Adjust trimmers C331 and C336 for maximum deflection on the watts/SWR meter, or the brightest glow from the lamp. The power output should be more than 150mW.

Troubleshooting

If for some reason your unit doesn't check out according to the above tests, here's what to try next.

1. Check the following DC voltages:

		RX	TX
Q301	drain	6.0V	0V
	source	0.3V	0V
	gate1	0V	0V
	gate2	3.8V	0V
Q302	drain	7.2V	0V
	source	0.3V	0V
	gate1	0V	0V
	gate2	0.3V	0V
Q303	base	1.2V	1.2V
	collector	6.8V	6.8V
	emitter	0.6V	0.6V
Q304	base	0.6V	0.6V
	collector	6.5V	6.5V
Q305	base	0V	0.6V
	collector	0V	13.0V

2. Amplification of the LO driver stages can be checked with an RF probe (compare the signals between the base and collector). The equivalent DC levels measured with such a probe should be:

		RX	TX
Q303	base	20mV	20mV (-14dBm)
	collector	1.4V	1.4V (0dBm)
Q304	base	0.5V	0.5V (0dBm)
	collector	6.0V	6.0V (+8dBm)
D303	cathode	1.5V	1.5V (+7dBm)
	anode	1.6V	0V
D304	cathode	1.5V	1.5V
	anode	0.1V	1.4V
Q305	base		1.0V (+4dBm)
	collector		10.0V (+21dBm)

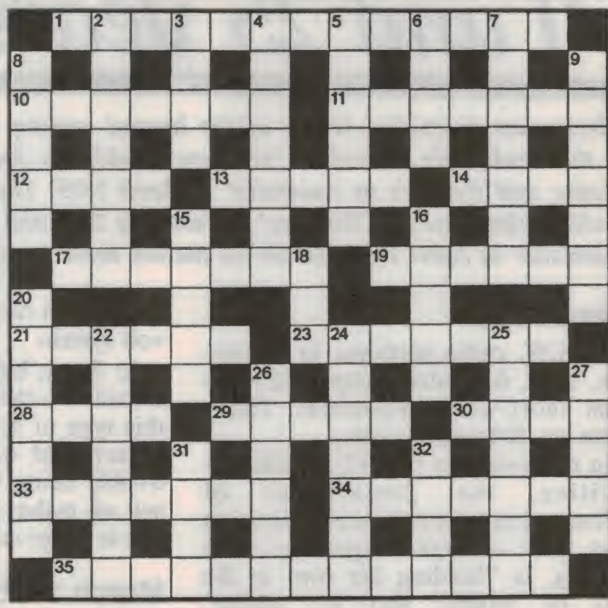
Note that the levels in brackets were measured directly with a 50-ohm power meter.

Hopefully the results of these measurements will allow you to track down the cause of any problem.

And with that, we'll take a break until next month, when we'll deal with the remaining circuit sections. In the meantime, you'll be able to use your part-finished transceiver as a receiver, to listen in on the 2m FM channels in your area.

(To be continued) ■

EA CROSSWORD



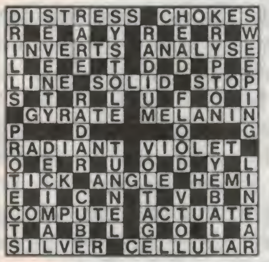
Across

1. Source of telephonic time. (8,5)
10. Inhibit the activation of another circuit. (4,3)
11. Said of numbered data. (7)
12. Major component of a photocopier. (4)
13. Be consistent in measure ments. (5)
14. Point of zero oscillatory displacement. (4)
17. Group of affiliated television stations. (7)
19. Quasi-stellar source of radiation. (6)
21. Evidence of ions in the Wilson cloud chamber. (6)
23. External TV apparatus, the antenna and ----. (3,4)
28. Make a circuit pattern. (4)
29. Position in decimal notation. (5)
30. Particulate pollution. (4)
33. Complex instrument preceding the electronic organ. (7)
34. Unwanted quality in an instrument's pointer. (7)
35. Outmoded communication ducts. (8,5)

Down

2. Image. (8)
3. Conversion of data. (1-2-1)
4. Whole number. (7)
5. Device. (6)
6. Differs in phase. (4)
7. Charged particles. (7)
8. Type of pot. (5)
9. Mathematical process for problem solving. (7)
15. Factor in ignition timing. (5)
16. Substitute used in test circuits. (5)
18. Assemblage for an EA project. (3)
20. Venture; endeavour. (7)
22. Powerful source oflight. (3,4)
24. Making unauthorised use of computer. (7)
25. Space craft. (7)
26. Chemical base. (6)
27. Broad flexible conductor. (6)
31. Greek letter. (4)
32. List of options. (4)

SOLUTION TO FEBRUARY



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6	31	56	81	106	131	156	181	206	231	256	281
7	32	57	82	107	132	157	182	207	232	257	282
8	33	58	83	108	133	158	183	208	233	258	283
9	34	59	84	109	134	159	184	209	234	259	284
10	35	60	85	110	135	160	185	210	235	260	285
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18	43	68	93	118	143	168	193	218	243	268	293
19	44	69	94	119	144	169	194	219	244	269	294
20	45	70	95	120	145	170	195	220	245	270	295
21	46	71	96	121	146	171	196	221	246	271	296
22	47	72	97	122	147	172	197	222	247	272	297
23	48	73	98	123	148	173	198	223	248	273	298
24	49	74	99	124	149	174	199	224	249	274	299
25	50	75	100	125	150	175	200	225	250	275	300

MAR '91

50 and 25 years ago..

'Electronics Australia' is one of the longest running technical publications in the world. We started as 'Wireless Weekly' in August 1922 and became 'Radio and Hobbies in Australia' in April 1939. The title was changed to Radio, Television and Hobbies' in February 1955 and finally, to 'Electronics Australia' in April 1965. Below we feature some items from past issues.

March 1941

10 S.W. radio stations: In December, 1939, Australia inaugurated overseas short-wave broadcasts. Today there are 10 transmissions.

In reviewing its first 12 months' activities, the Department of Information's broadcasting division says that Australia, speaking from Sydney, is "holding her own in the war of words, and is 'selling' Australia overseas."

Emphasising its work of rebutting enemy propaganda, the department says there have been several notable instances where the Prime Minister's replies to enemy lies, picked up by the department's listening posts, have been broadcast from Sydney radio.

Your query answered for a shilling: H.K.B. (Moss Vale) wants the circuit of a car radio suitable for a 12-volt system.

A: Sorry, but we haven't a suitable circuit of a car radio. We have held off this type of set owing to certain constructional difficulties. The main trouble being to build a set that will suit all makes of cars, and believe us, this is easier said than done.

March 1966

Market research: Marketing researchers are making increasing use of electronic data processing and statistical techniques in their efforts to analyse and predict consumer responses. Pioneers in this fast-moving field are Audience Studies Inc., who have developed a specialised analogue computer system capable of accurately predicting the success or failure of motion pictures, TV series, radio and TV commercials, live shows and even printed advertising. With installations already established in the USA, Britain and japan, this organisation has recently installed a new computer in Anzac House, Sydney.

Solid state TV link: The first completely solid-state UHF transmitter for beaming television programs is currently operating under the supervision of the Australian Post Office for transmissions from Sydney to Madden's Plains, near Wollongong, NSW. The equipment was supplied by S.T.C., who say that all other radio link equipment in use throughout the world for transmitting television signals has at least one valve. The Sydney end of the link is located at the P.M.G. building at Redfern. The equipment is designed to operate at a carrier frequency of 2,000MC.

Veroboard: Those experimenters who feel that the advent of the mass produced printed wiring board has robbed the home builder of his individuality, will welcome the latest innovation in this field. Called 'Veroboard', it is a pre-punched, pre-etched board with a uniform hole and wiring pattern easily adaptable to almost any circuit configuration. ■

Electronics Australia with ETI

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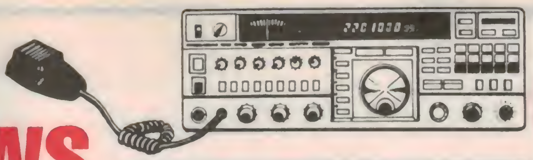
Amateur Radio News



FCC creates 'codeless' class of licence

In February this year it became possible for the first time to obtain a US amateur radio licence without passing a Morse code test. The American FCC has eliminated the need for new 'Technician' class licence applicants to demonstrate proficiency in Morse, before receiving all amateur operating privileges above 30MHz.

According to the ARRL, the FCC took this action in response to numerous petitions and public comments. One of the organisations which petitioned for a codeless licence was the ARRL itself, with some 154,000 members.

The codeless Technician licence is designed to provide an entry point in amateur radio for technically qualified people who find the Morse code to be a barrier. At the urging of the ARRL and others, the FCC decided to retain the current Novice class licence with its 5wpm Morse code requirement, for those that prefer this entry point.

At a press briefing held just after the change had been announced, FCC Private Radio Bureau Chief Ralph Haller said "The Amateur Service is not growing as it should, relative to what it has to offer."

Mr Haller observed that it was from amateur radio that the US nation's electronics expertise sprang, and that the changes should attract into amateur radio people who are interested in computers and digital communications, as well as helping to make US industry more competitive.

WIA clarifies role of 'Intruder Watch'

In a recent broadcast, the NSW Division of the WIA clarified the responsibilities of the Australian Intruder Watch Service. Apparently there has been some confusion over this.

Operating under the IARU Monitoring Service, the AIWS is charged with monitoring *international* intrusions into amateur bands. It does not cover any local 'pirate' activity, within Australia. Such transmissions should apparently be reported to the DoTC, together with any corroborative evidence such as beam headings.

The WIA VK2 Division has appointed a DoTC Liaison Officer, who has access to the highest levels of the DoTC in Sydney. It therefore suggests that reports of local pirate activity be given to the Division's DoTC Liaison Officer, for collation and review. The officer can be contacted via the Divisional Office, PO Box 1066 Parramatta 2150; phone (02) 689 2417.

Over 1 million hams in Japan

The latest issue of the WIA's *Amateur Radio* magazine passes on some interesting statistics regarding the world's ham population. According to the Japan Amateur Radio League (JARL), the number of licensed amateur radio stations in Japan now stands at 1,027,101. This is very close to *half* of all the licensed hams in the world.

The country with the next largest amateur population is the USA, with 494,114 licensed stations, accounting for another quarter of the world's population.

For reference, the latest Australian DoTC figures show 18,655 licensed amateur stations, not including repeaters and beacons. This is less than 1% of the world total.

20-year 'AR' index on disk

Speaking of *Amateur Radio*, the WIA can apparently provide its members with an up-to-date index of this publication for the last 20 years, on IBM-format floppy disk. The index is available on either 3.5" or 5.25" disk, and in the form of either a .DBF file for dBase III Plus, or an ASCII file for access with a word processor.

Copies are available from the WIA Federal Executive Office, 3/105 Hawthorn Road, Caulfield North 3161, for $10.00. A hard copy is also available, for $5.00. The index is updated on a monthly basis. ■

Electronics Australia is happy to promote the activities of amateur radio clubs and organisations, in this column. Send details to the Managing Editor, EA, PO Box 199, Alexandria 2015.

Vintage Radio

by PETER LANKSHEAR

Rewinding output transformers

A frequently encountered problem in servicing valve radios is that of open-circuited audio transformer windings. Suitable replacements are hard to find, creating a serious problem in restoration projects. This month, we describe a practical method of using simple tools to rewind speaker transformers.

As explained in my previous column, transformer failures are generally the result of electrolytic corrosion of fine wire, the culprit being acidic paper insulation. Often this is the reason for a valve radio having been 'retired' as unservicable.

During the valve era, such was the rate of failures that there was a thriving trade in winding replacement transformers, making them readily available at competitive prices. There is no alternative to replacing or rewinding a defective transformer, but today production of audio transformers has ceased, leaving the vintage radio enthusiast with a major problem.

If you are lucky, you may locate a rewinding specialist, but his services can be expensive. Usually, restorers resort to 'cannibalising' transformers from other radios, or substituting unsuitable transformers intended for other duties — neither of which are very satisfactory alternatives.

Machinery not essential

Many vintage radio enthusiasts regard transformer winding as a 'black art' requiring considerable expertise and expensive machinery, and will not treat seriously any suggestion that rewinding an output transformer can be done in the home workshop.

Certainly, the traditional method of winding several thousand turns of fine primary wire — interleaved with paper — can, when done by hand, be a daunting task; although it has been done. Fortunately, using modern materials, it is unnecessary to display such patience. Modern wire coverings are so reliable and durable that today, as a study of a modern small transformer will reveal, fine gauge windings are simply piled on randomly without any interleaving paper on to molded bobbins, available in a

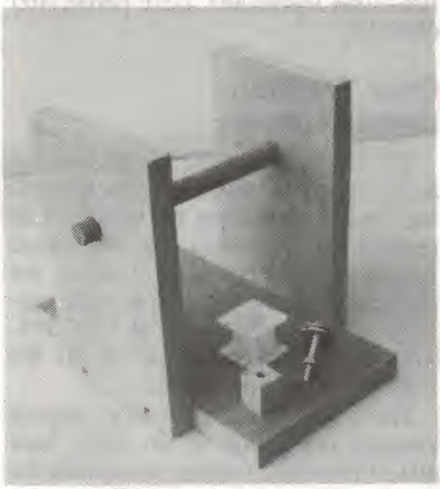


Fig.1: The equipment required is minimal — a spool holder, a mandrel and a 6mm bolt with washers.

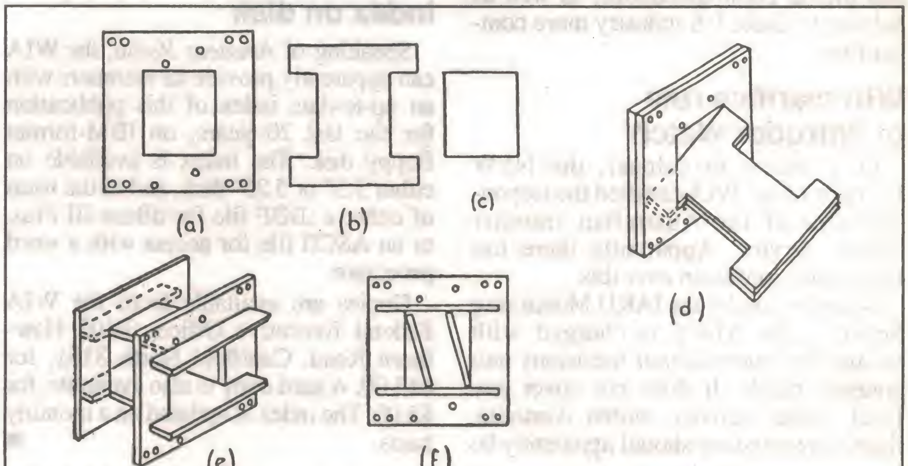
wide range of sizes. Even mains transformers are now made this way, with little risk of breakdowns.

As the photographs show, the only essential tools for transformer winding are a small vice, a hand drill, a long bolt with washers, and a simple support for a reel of wire. The drill is clamped in the vice and is used to rotate the bobbin mounted on the bolt. The main requirement for the reel support is that it should allow the reel to turn freely with a minimum of friction. Ideally, a spindle with threaded cones and running in ball races would be used, but a wooden dowel that is a close fit in the reel is quite satisfactory.

Remove and dismantle the transformer. If it is mounted on the loudspeaker, take care when you are drilling out rivets that metal particles don't get into the voice coil area. As speakers with energised fields generally have a humbucking coil in series with the voice coil and secondary winding, take a note of the connections.

Opening it up

Now open any tabs locking the cover to the core. The cover can be prised off and the core separated from the winding. Unless the receiver has a pushpull output



A method of making your own bobbin, using thin fibre board or Formica.

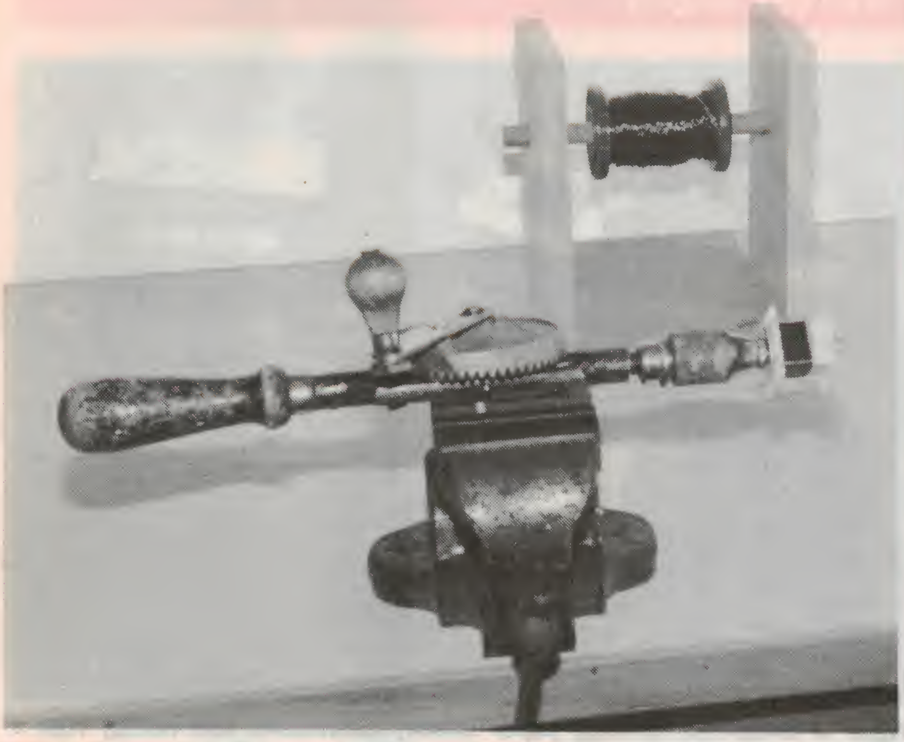


Fig.2: The simple setup, with a partly completed secondary winding visible.

stage, the E and I core laminations will not be interleaved, but simply butted together with a piece of thin paper as a spacer.

An original winding will have been made in the traditional manner, with alternate layers of wire and paper on a fibre or cardboard rectangular tube. Peel off the outer paper or tape and the thick outer secondary or voice coil winding will be uncovered. Unwind this wire, noting the number of turns, typically somewhere between 50 and 100.

Underneath a layer of insulation will be the primary, consisting of several thousand turns of fine wire. Counting them would be a tedious business, likely to put anyone off transformer winding forever. However, this is unnecessary as calculation is quite easy.

New bobbin

A wide range of plastic bobbins is made but it may take a bit of shopping around to locate a source. Although generally not stocked by the major electronic supermarkets, smaller suppliers often have transformer bobbins available, or know where to get them. Take along your core to make sure that you get the right size. If you are unlucky enough not to be able to obtain a suitable bobbin, a very practical method of fabrication from thin fibre or Formica is shown in the diagram.

A typical transformer does not require a lot of wire, but small quantities purchased from electronics suppliers can be prohibitively expensive. A full reel is much more economical, but would provide sufficient wire for a lifetime of rewinding. It may be possible to buy a part reel from a motor rewinder or similar firm.

For all but the smallest transformers, a suitable wire for primaries is 0.125mm (39swg) and for secondaries, 0.5mm (24swg). Use 0.11mm (41swg) and 0.4mm (27swg) respectively for the very small '3 watt' transformers.

TRANSFORMER RATIOS

VOICE COIL IMPEDANCE	ANODE LOAD 5K OHMS	ANODE LOAD 7K OHMS
2.0 OHMS	50:1	59:1
2.3 OHMS	47:1	55:1
3.5 OHMS	38:1	45:1
5.0 OHMS	32:1	37:1
8.0 OHMS	25:1	30:1
15.0 OHMS	18:1	22:1

LOADS FOR SOME FREQUENTLY USED VALVE TYPES

7,000 OHMS:	6F6,42,6BJ5,6BV7,47 59,EL3,EL33,6AG6G, KT63,6BQ5/EL84,2A5, 41,6K6.ECL86/6GW8.
5,000 OHMS:	6AQ5/6HG5.EL90,6V6. 6BW6

The next step, using a soft straight grained wood, is to make a mandrel to locate the bobbin on the 6mm bolt. Take care to ensure a snug fit and make it slightly shorter than the bobbin. Drill a 6mm hole, as accurately centred as possible. Any eccentricity will make even winding difficult. Assemble the washers (which relieve winding pressures on the bobbin walls), the mandrel and bobbin on to the bolt. Count the number of teeth on the drill gear wheels. For example, the drill illustrated has 56 and 15, so that for each turn of the handle there are 56/15 chuck revolutions. Now clamp the drill horizontally in the vice and tighten the bolt firmly in the drill chuck.

Secondary first

Traditionally the secondary was the outside winding, but there is no practical difference in performance if it is wound on first — which, with this method of rewinding, is more convenient.

Leave a few inches of secondary wire protruding through one of the slots and wind on a layer tightly and evenly. Check the number of turns and compare with those on the original winding. It is not essential for the final layer to occupy the full width of the bobbin, but it does provide a more level surface for the next winding. A variation of 10% in the total number of turns is quite acceptable. The transformer illustrated took 38 turns on the first layer, and the total for the original winding was 70. Two full layers came to 75 turns, which is quite close enough to the original. A piece of thin plastic tape was interleaved between the layers.

To complete the secondary, the end of the wire is brought out through a slot and the winding covered with two layers of plastic tape or plasticised paper (the paper backing for adhesive labels is ideal). This is cut a little wider than the bobbin to eliminate any possibility of primary turns dropping down on to the secondary.

Calculating the primary

Knowing the load for the output valve, the number of secondary turns, and the voice coil impedance, it is easy to calculate the primary turns required. The load impedance may be printed on the transformer or can be checked on a valve characteristic chart. Loads for some of the most frequently used valves are given in the accompanying table.

Sometimes beginners are confused to find that the DC resistance of a winding as measured by a test meter is only a fraction of the load impedance. Impedance in this case is the AC resistance of

Fig.3: A completed winding, paper spacer, laminations and clamp, with a reassembled transformer.

the voice coil, as reflected by the transformer, and with practical transformers is of the order of 10 times the DC resistance of the primary.

Many 'one inch' voice coils had a nominal impedance of 2.3 ohms and the 3/4" coils fitted to lightweight speakers were usually 3.5 ohms. In any event, as loudspeaker impedances vary wildly with frequency, these figures are quite nominal. As a guide, voice coil impedance is about 1.3 times the DC resistance.

The required turns ratio of an output transformer is the square root of the impedance ratio. For example, if a 6F6G requiring a load of 7000 ohms is to match a 3.5 ohm speaker, the required impedance ratio is 7000/3.5 or 2000:1. The turns ratio therefore, is the square root of 2000 or 44.7:1.

Some of the most common ratios are in the table. In our example, as the secondary has 75 turns, for an impedance ratio of 2000:1 the primary should have 75 x 44.7 = 3350 turns.

Winding the primary

This is one of the easiest parts of the project and takes only about 10 minutes. As the drill is geared the number primary turns required is divided by the gear ratio. In the example, this is 3350 x 15/56 = 897 turns of the drill handle. As it is easy to lose count, I use a pencil and paper to keep a tally during winding.

Terminate the start of the primary wire with a short length of thin hookup wire, making sure that there are no lumps of solder. Bring this lead out through a slot on the opposite side of the bobbin from the secondary leads.

Position the hookup wire so that it goes the full width of the bobbin and fasten it down with a piece of tape, making sure that the splice is completely covered.

Maintain tension

Commence winding, turning the drill handle steadily with one hand and guiding the wire with the other. Maintain a slight tension on the wire, building up the winding evenly. Take care not to drop turns over the edges of the bobbin.

At the finish of winding, use another piece of thin hookup wire for leading out. To lock this wire in position, fold the end into a 'U' so that it crosses the winding twice, inserting a piece of tape between it and the winding and fasten it down with another piece of tape.

After covering the outside of the winding with a couple of layers of tape, or varnished paper, all that remains is to reassemble the bobbin and core, not forgetting the piece of paper in the gap between the two bundles of laminations.

You will now have at small cost, a transformer with a performance equal to the original, and with the advantage that it will be much more reliable.

Why not give it a try? ■

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A look behind the technology:

How Toshiba succeeded in the 1Mb DRAM race

Back in 1981, Toshiba was perceived as lagging its competitors in the development of semiconductor memory chips. By 1990, it had surged forward to become world leader in the 1-megabit DRAM market. The story of how this dramatic turnabout was achieved gives a good insight into the long-term strategy, vision, committment and determination of Japan's electronics industry.

by KEI SHIRATORI

Today Toshiba holds the largest share of the world one megabit DRAM market. How did the company reach this leading position? According to Tsuyoshi Kawanishi, Senior Executive Vice President of Toshiba, "Just nine years ago Toshiba was struggling to produce the 64K-DRAMs that were then the mainstay of the computer memory market."

The company's backwardness was often whispered among its competitors, and the Japanese media even reported on it, adding to the apprehensions of the semiconductor division.

I was interested in how a company with all these problems with semiconductors decided to make such a large committment to their development, and how it managed to carry it out so successfully.

President's decision

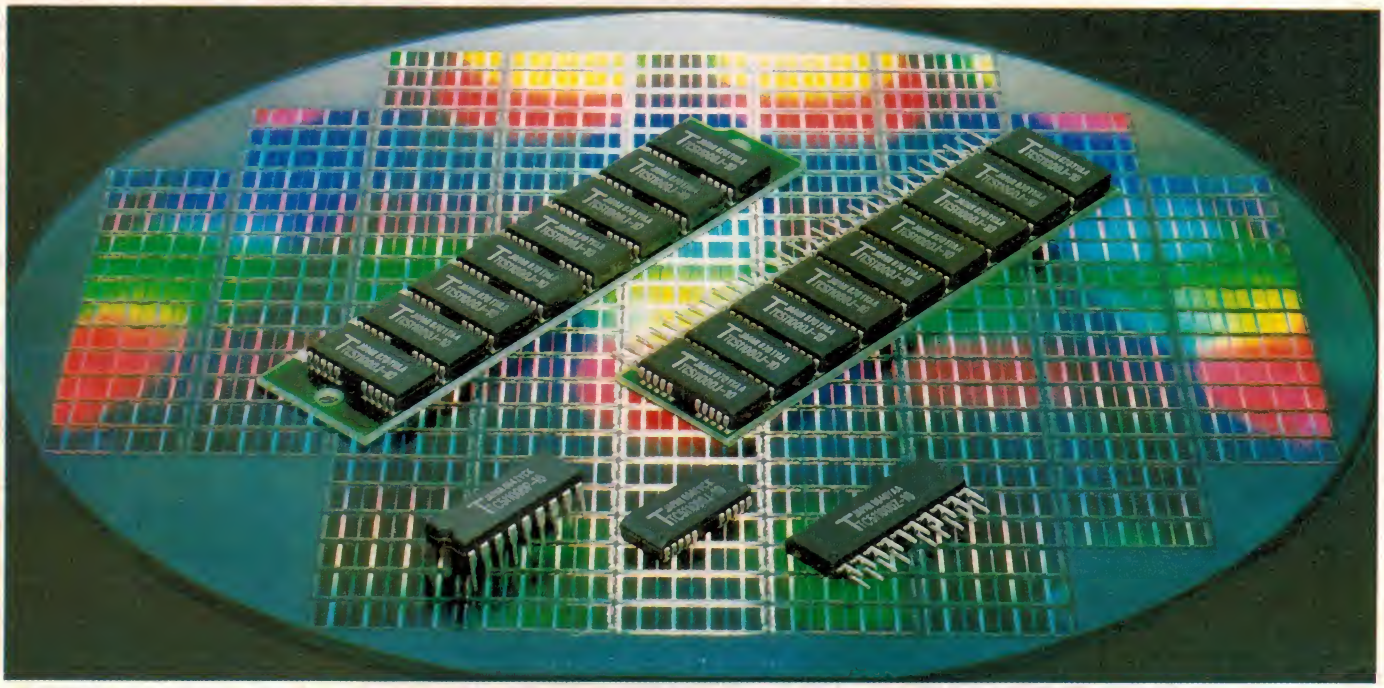
The semiconductor business is quite risky, though strategically important. It needs huge capital investments as well as excellent human resources. Severe competition among innovative chip makers worldwide pushes forward rapid technical advances.

Periodical ups and downs in the market — the 'silicon cycle' — see years of high sales characteristically followed by slumps.

Despite the potential riskiness of semiconductors, by 1981 Shoichi Saba, then President of Toshiba, had come to recognise their strategic importance as the future building blocks of all electronics equipment, and as essential for the company's sustained growth.

He was seriously thinking in which area and how much the company should invest to make Toshiba a leading player in the emerging market.

In October of the same year, Kawanishi was appointed the leader of Toshiba's semiconductor business. He



1M DRAMs in various packages on a wafer of DRAMs ready for cutting.

wanted to revitalise the company's semiconductor business and catch up and overtake other semiconductor manufacturers, but it required such a huge investment that he was not sure the company could afford it. Dr Yoshiyuki Takeishi, now Director of the ULSI Research Centre, had also reached the same conclusion. He felt Toshiba needed a research facility for long-range LSI development, independent of semiconductor business divisions, in order to catch up with other companies and to assure Toshiba's leading position in the future.

At the end of 1981, Kawanishi and Dr Takeishi independently decided to ask President Saba to invest more in the semiconductor field. Both came up with concrete data and explained to President Saba in a persuasive way that the company should be involved full scale in t he semiconductor business.

Their strong requests may have helped Saba make his final decision. Dr Takeishi recalls the time: "I wondered whether I should have made such a daring request when the company was in a business depression, but now I really think it was the right decision."

In his 1982 New Year address, Saba announced strategic investments in semiconductors totalling 32 billion yen (US$213 million).

The Oita and Kitakyushu Plants were to take the lead in semiconductor research and development, and build up the plant and equipment necessary for mass production.

The scale of the investment may seem relatively small compared with current levels, but 32 billion yen then represented almost 21% of total investment made by the parent company, and an increase of 60% over the previous year. Toshiba's investments in the semiconductor field since then are shown in the graph.

The decision confirmed the depth of the company's commitment to semiconductors. The philosophy behind it is well expressed in comments Saba made at the time: "The Industrial Revolution in 18th century Europe was a revolution in mechanical power replacing human force. From now on I believe, semiconductors will become the driving force, replacing the mechanical power of the first Industrial Revolution. Semiconductors are vital for further development of Toshiba as a whole; for our industrial electronics business as well as the consumer elelectronics and for heavy electrical apparatus business."

The centrepiece of the investment was a new laboratory complex, now the ULSI Research Centre in the company's R&D Centre at Kawasaki, which cost more than 20 billion yen (US$133 million). Completed in 1984, the labs boasted a 2500 square-metre 'ultra clean room,' one of the most advanced clean rooms in the world at that time.

Dr Fjio Masuoka, Senior Manager at the ULSI Research Centre, was elated with the new facility. "We were the first company to set up a clean room exclusively for development use. Before that, we had to use the room set up for wafer production and our development work always came second to production. We always had to reserve the equipment for trial fabrication in advance, and sometimes had to wait a week ore more before we could get in there.

Once the new clean room was finished, the R&D people at the ULSI Research Centre were able to really speed up development time and that really made a lot of difference."

With the foundations in place, there was still one major question to be answered. Would success follow? The stage was set for the technical personnel to show their worth.

Project W

In 1983, with the object of vitilising Toshiba's semiconductor business by giving its people a clear goal that would unite them in a shared effort, Saba and Kawanishi initiated 'Project W'. The W symbol was made up of two Vs: one for victory in making semiconductors a

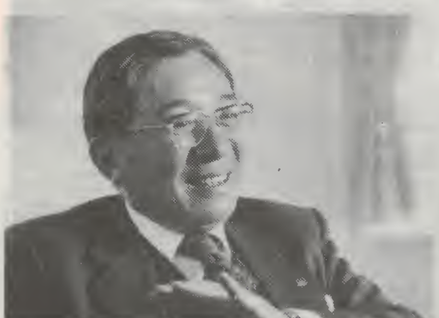
1M-DRAMS and their background

Dynamic random access memories (DRAMs) are widely used in computers, word processors, facsimile machines, PBXs and digital VCRs. They store programs, images and alphanumeric data.

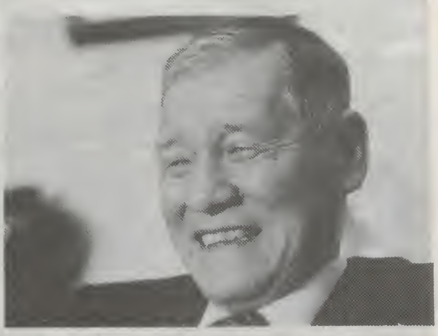
DRAMs represent approximately 15% of a semiconductor market that has seen annual growth rates as high as 42.8% a year during the last five years. Their development is of vital importance to semiconductor manufacturers. Each enhancement of DRAM storage capacity leads directly to further miniaturisation of electronic equipment and advances in product features and reliability. Perfecting new generations of DRAMs calls for wide-ranging sophisticated technologies which can be applied later in the development of other semiconductor devices. That is why DRAMs have become the technology driver in semiconductors, and why microchip manufacturers all over the world are in a race to increase DRAM capacity.

Only ten years ago, 64-kilobit (K) DRAMs appeared, and the age of VLSI (very large scale integration) began. By 1982, one microchip' had entered the language, and memory capacity had increased four times, to 256K; in 1986 came the present mainstream product — one megabit DRAMs, able to store the equivalent of four newspaper pages on a chip. Now a new stage has been reached with the start of mass-production of 4M-DRAMs.

Shoici Saba, Advisor to the Board and formerly chairman and president.



Tsuyoshi Kawanishi, Senior Executive Vice President.



Dr Yoshiyuki Takeishi, Director, ULSI Research Centre.

1Mb DRAM race

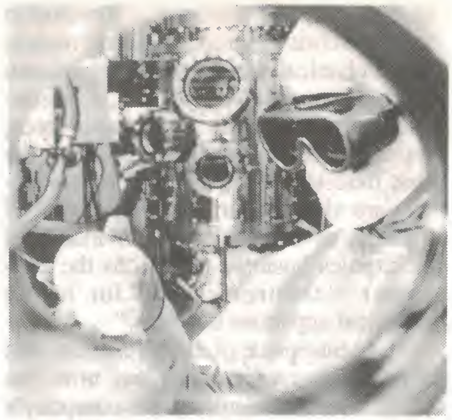
mainstay of Toshiba, the other for value added to Toshiba products by the incorporation of company-developed semiconductors. Their combination in a W pointed the way to the company's goal; worldwide success.

Project W channelled the company's investments into vast improvements in the quality and scale of research and production facilities, and to increases in the number of technical personnel. On the engineering side, the 1M-DRAM Development Project Team held the central position. Koichi Suzuki, now General Manager of LSI Division II, was appointed the leader of the project team. The company's continuing commitment to developing a successful semiconductor business made sure he got the support he needed. In fiscal 1983, Toshiba invested 97 billion yen (US$647 million), about 35% of its total capital investment for the year, and an increase of 203% over fiscal 1982.

Crucial Choices

In February 1985 at the annual ISSCC (International Solid State Circuits Conference) in New York, Toshiba revealed it had developed a prototype 1M-DRAM.

It was a move none of the experts gathered from around the world had expected. Looking back, Dr Takeishi says, "The announcement really surprised a lot of researchers in the industry. And it brought Toshiba into competition with the leading memory devices makers."



A laboratory showing workers in their special clothing.

Shozo Saito, now a manager in the Memory Application Engineering Department, remembers the pressure everybody worked under during the development period.

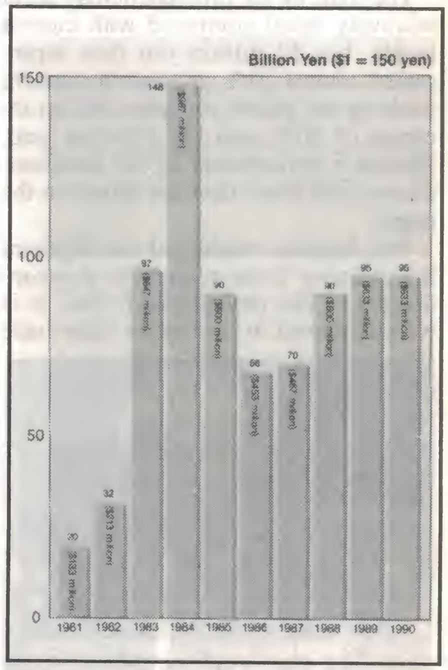
"Our team had already been given the equipment and the engineers to reinforce development of megabit chips. What we had to do was to bring the device to the market earlier than any of our competitors. Kawanishi gave us a clear goal; the 1M-DRAM development project team had to become 'Number One in the World'. We had monthly meetings with Koichi Suzuki, the project leader, where any mention of the world 'delay' brought down reminders of the many serious challenges we were facing. But now we can look back on those times fondly."

Suzuki's points were well made. Any delays could prove fatal to the team's efforts and Toshiba's attempts to bring the first commercialised 1M chips to the market. And that carried the risk of putting the company even further behind the competition. Particularly risky were potentional delays from a mistake in choosing the appropriate type of device. Ultimately, the engineers' efforts and Toshiba's success depended on correct decisions on chip structure. Among the many choices made at each development stage, two were crucial.

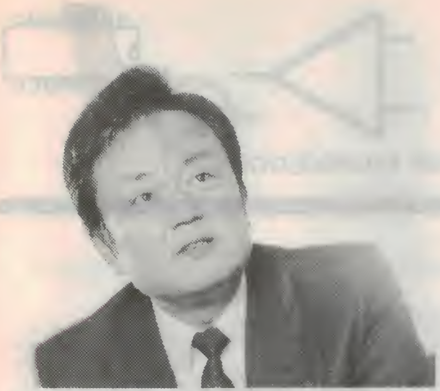
The first concerned the basic device of the structure. What was it to be, N-MOS (Negative-channel Metal Oxide Semiconductor) or C-MOS (Complementary MOS)? Since each structure had merits and demerits, it was impossible to simply discuss them and then opt for one without full-scale development of both. Their potential had to be fully investigated and carefully evaluated, so two research teams were pitted against each other to test the structures. This style of research was new and unique for Toshiba.

Engineers worked daily around the clock in a race against time and the competition, some even begrudging time off for lunch. They laboured at pattern design, sandwich in hand. The result of their intense efforts was a trial product from both groups, ready for comparison as production deadlines neared. After evaluating the results, project leader

An aerial view of the ULSI Research Centre and R&D Centre.



Investment in the Semi-conductor development.



Koichi Suzuki, General Manager, Liquid Crystal Display Division.

Taizo Nishimuro, General Manager of Overseas Operations Support Division.

Joichi Aoi, President and CEO.

evaluating the results, project leader Suzuki finally decided on the C-MOS type. It offered a higher degree of reliability and was more suitable for mass-production. "We felt confident when other companies that first adopted N-MOS structure later switched to C-MOS," Suzuki says.

The group of engineers that developed the N-MOS version were naturally downhearted that their efforts had not led to final success, but could console themselves with the knowledge that their work had served a useful purpose.

The second crucial choice Toshiba had to make was whether to adopt a 'planar' or 'trench' structure. For technical reasons, the research engineers preferred the trench structure, but the production engineers argued that their familiarity with conventional planar devices promised better mass-producitivity and earlier commercial production. These factors led Suzuki to a decision for the planar structure.

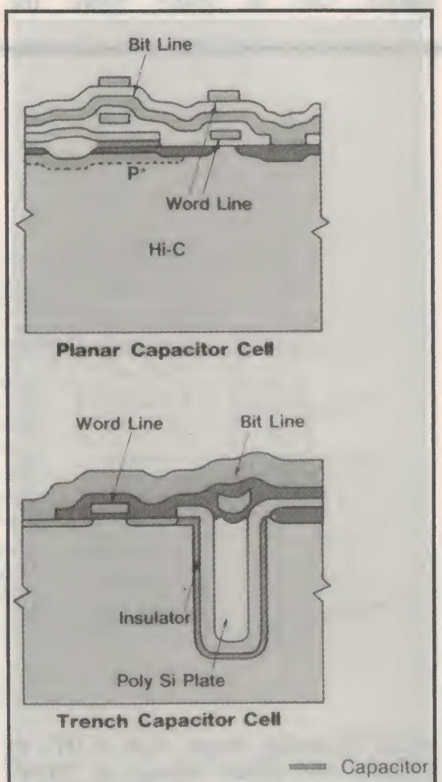
Around the time that Toshiba announced this, a number of other Japanese makers revealed they had selected trench versions. "I had to admit it, I was worried when I heard that," Suzuki says. But, as the world's major chipmakers started mass-production, his decision turned out to be the right one. Some of the companies that opted for the trench structure later switched to planar. And far from being a dead-end, the company's research in trench structure made a major contribution to the early development of four megabit DRAMs.

Policy of Commitment

Once the one megabit device had been put into production, the onus for success switched to Toshiba's marketing and sales departments. They played a key role in Toshiba's drive for the number-one position, especially during the worldwide DRAM shortage of 1987 and 1988. At that time, because of the buoyant market for computers and other electronics devices, demand for 1M-DRAMs increased rapidly and far outstripped worldwide supply.

Taizo Nishimuro, the present General Manager of the Overseas Operations Promotion Division, was then responsible for maintaining supplies to Toshiba's customers int he world markets.

"We did our best to be far to all our customers," he says. "Our policy is to value long-term relations based on mutual trust rather than seeking short-term windfall profits. Needless to say, we made no distinction between domestic or foreign users."



This diagram shown the structure of a memory cell.

Asked why the company did not raise prices even in a supply-shortage market, the way some others did, he says, "It's a part of Toshiba's corporate management philosophy. It can be seen in the slogan initiated by President Joichi Aoi, 'Committed to People, Committed to the Future. TOSHIBA'. We did not raise prices, and we tried to offer stable supplies. We followed this policy even when it came to our in-house consumption. As a result, Toshiba itself suffered chip shortages on the laptop and workstation production lines. A lot of people in the company held this against me, but it showed how much Toshiba respects its customers. And I think it helped us consolidate our position as the leading one megabit DRAM producer. That makes it all worthwhile."

Looking ahead

Since its pioneering efforts in one megabit DRAMs, Toshiba has continued its capital and human investments in the equipment and research vital to developing new generations of memory devices. Under the firm leadership of its current President, Joichi Aoi, the company ploughed around 90 billion yen (US$600 million) a year into semiconductor operations in both 1988 and 1989, and planned to maintain the same level in 1990. The company will see the fruits of this, when Toshiba will be producing more than one million units of 4M-DRAMs a month.

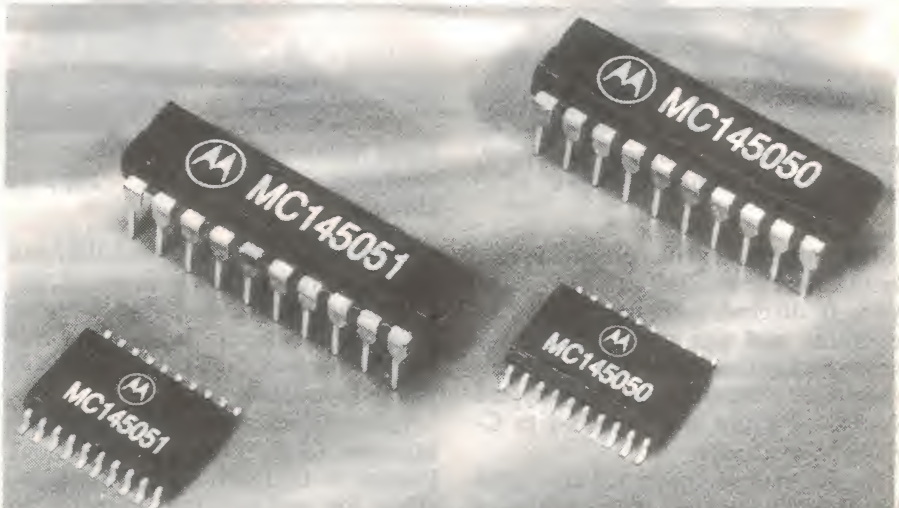
After its success in the one megabit market, a new question is being asked about Toshiba.

Will the company be able to win the top share of the new 4M-DRAM market? That remains to be seen, but Toshiba seems to have a lot of confidence. A great number of people are watching with interest. ■

Solid State Update

KEEPING YOU INFORMED ON THE LATEST DEVELOPMENTS IN SEMICONDUCTOR TECHNOLOGY

10-bit A/D converters with serial interface



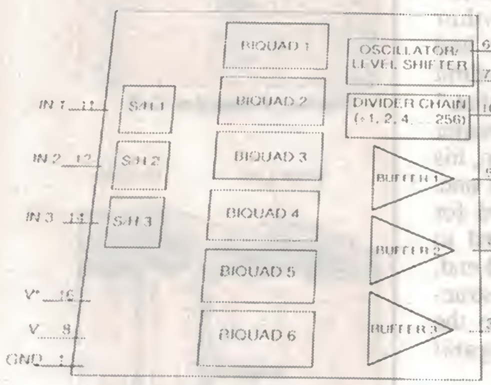
Motorola's MC145050 and MC145051 ratiometric 10-bit A/D converters feature serial interface ports to provide communication with MCUs and MPUs. Each operates in either 10-bit or 16-bit serial formats from a single 5V power supply, without external trimming. Power consumption is a low 14mW. Packaging options include both DIP and SOIC configurations.

The MC145050 features the same pin-out as the 8-bit MC145040, allowing an internal clock (ADCLK) to operate the dynamic A/D conversion sequence. The MC145051 pin-out matches the 8-bit MC145041's, providing an internal clock oscillator and an end-of-conversion (EOC) output. With reprogramming, MC145040/41 users can upgrade their current applications to take advantage of the new 10-bit parts.

Numerous features enhance the products design-in appeal. Eleven analog input channels with internal sample-and-hold are provided. Successive approximation conversion time for the MC145050 is 21us (with 2.1MHz ADCLK) and 88us maximum for the MC145051. The MC145050's maximum sample rate is 38ks/s while the MC145051's is 10.7ks/s. Both ICs are monotonic, with no missing codes.

For further information circle 273 on the reader service coupon or contact Motorola Semiconductor Products, Suite 3, 673 Boronia Road, Wantirna 3152; phone (03) 887 0711.

Mask programmable switched-C filter



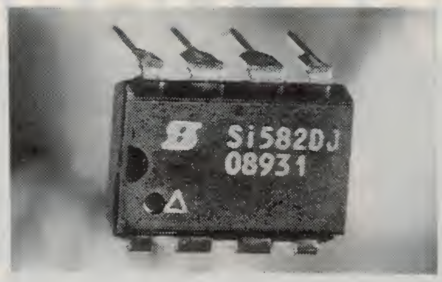
National Semiconductor has announced the LMF120 and LMF121 mask-programmable switched-capacitor filter arrays. The new devices are capable of implementing up to a 12-pole filter in one 16-pin, cost-effective package. The new semi-custom filter arrays are designed for a number of applications including communications systems, such as mobile phones, anti-alias filters, biomedical instrumentation, control systems, and real-time audio analysers.

Both the LMF120 and LMF121 silicon-gate filter arrays can realise all filter types – low-pass, high-pass, bandpass, notch, all-pass, and all filter approximations including Butterworth, Eliptic, Chebyshev and Bessel. The LMF120 has right-half-plane zeros whereas the LMF121 has left-half-plane zeros. Up to three independent filters may be implemented in one LMF120/1, which is equivalent to three LMF100s or MF10s in one package. Key specifications for the LMF120/1 include wide-centre or cutoff frequency range from 0.1Hz to 100kHz, low offset voltage of 70mV, and low power consumption of 100mW at +5V.

For further information circle 288 on the reader service coupon or contact National Semiconductor Australia, Building 16, Business Park Drive, Monash Business Park, Nottinghill 3168; phone (03) 558 9999.

Op amp has 180MHz bandwidth

Siliconix has released a new closed-loop, low-gain amplifier for wideband signal routing and switching applications. The new Si582 is specifically designed for use with the company's D/CMOS wideband/video switches, multiplexers, and crosspoints, to improve system performance while reducing component count, design complexity, board space, power dissipation, and costs.



The Si582 amplifier features high bandwidth (180MHz), low signal distortion (–60dBc at 20MHz), excellent gain flatness (0.4dB to 50MHz), fast settling time (0.05% in 12ns), and low power dissipation (150mW). Its closed-loop design uses current feedback to achieve high accuracy and to minimise signal degradation. The Si582 also has low differential gain (0.1%) and low differential phase (0.0°, crucial for professional/studio applications.

The Si582 is suited for low-gain, wideband applications such as video switching routing for video equipment, radio communications, data communications (e.g., local area networks and ISDN equipment), automated test equipment, and high-resolution displays.

For further information circle 282 on the reader service coupon or contact IRH Components, 32 Parramatta Road, Lidcombe 2141; phone (02) 748 4066.

First true 1-chip Teletext decoder

Philips Components has released the world's first true single chip 625-Line Teletext decoder for analog TVs. The Philips' industry standard ECCT and VIP-2 (enhanced computer controlled teletext and video input processor) chip set can now be replaced by a single circuit.

The new integrated VIP and Teletext (IVT1) comes in two versions, each of which eliminates 40 extra peripheral components from a TV's Teletext section. Upwardly software compatible with their predecessors, the ICs perform the same functions – while cutting power consumption from 2.6W to 600mW and working from a single 5V supply.

The SAA5246 (ITV1.0) has the full four acquisition channels of the ECCT/-VIP-2 chip-set, and can therefore acquire four Teletext pages simultaneously, storing them in external 8K-by-8-bit RAM. The SAA5244 (IVT1.1) is primarily aimed at small-screen TVs, providing one acquisition channel, and storing the acquired page in on-chip RAM.

Both ICs replace the analog data slicing used by the ECC/VIP2 chip set with digital data slicing and also incorporate analog circuits and ADCs. They connect to a microcontroller across the industry-standard serial, two-wire I^2C-bus and there is an RGB interface to standard colour decoder ICs, with a push-pull output drive.

For further information circle 290 on the reader service coupon or contact Philips Components, 11 Waltham Street, Artarmon 2064; phone (02) 439 3322.

5V regulator with ultra-low Iq

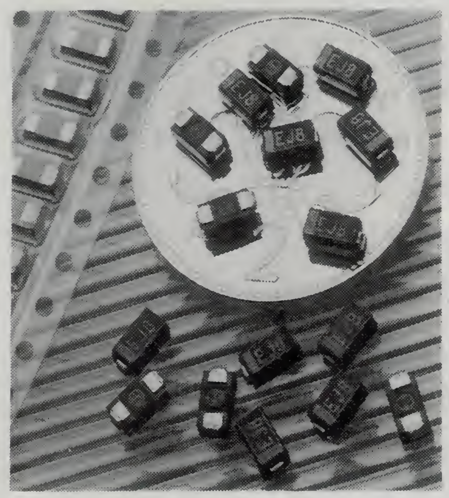
The National Semiconductor LM2936 ultra-low quiescent current regulator features low dropout voltage and low current in the standby mode. With less than 15uA quiescent current at a 100uA load, the LM2936 is ideally suited for automotive and other battery operated systems.

The LM2936 retains all of the features that are common to low dropout regulators, including a shutdown. The LM2936 has a 40V operating voltage limit, –40°C to +125°C operating temperature range and +/– 2% output voltage tolerance over the entire output current, input voltage and temperature range. The LM2936 is available in a TO-92 package with a fixed 5B output.

For further information circle 283 on the reader service coupon or contact IRH Components, 32 Parramatta Road, Lidcombe 2141; phone (02) 748 4066.

Surface mount Schottky diodes

Three new single-die Schottky rectifiers from International Rectifier are housed in miniature moulded packages



measuring only 5.5 x 2.8 x 2.25mm. Featuring voltage ratings of 40, 60 and 90V, the rectifiers have current ratings of 1.1, 0.77 and 0.77A respectively.

The IOMQ series is particularly suitable for surface mounting or hybrid applications as well as high density packaging where space is at a premium.

For further information circle 271 on the reader service coupon or contact NSD Australia, 205 Middleborough Road, Box Hill; phone (03) 890 0970.

Dual baud rate generators

The Microchip Technology AY58116/8136 series is a very versatile family of dual baud rate generators. The AY58116/8116T and AY58136 /8136T are pin for pin functionally equivalent to SMC's COM8116/8116T and COM8136/8136T, respectively.

The AY58116/8136 is designed to generate over the full spectrum of 16 asynchronous/synchronous data communication frequencies for use with 16x and 32x UART/USRT devices. An on-chip crystal oscillator available on the 8116 and 8136 is capable of providing a master reference frequency. Alternatively, complimentary TTL level clock signals can be input to pins 1 and 18. The 8116T and 8136T are only suitable for this external TTL reference.

For further information circle 284 on the reader service coupon or contact Fairmont Marketing, 726 Plenty Road, Preston 3072; phone (03) 471 0166.

Wide Band Receivers...

ICOM has broken the barriers with its new line of wideband receivers built to go the distance. Introducing the IC-R1 handheld receiver, the IC-R72 HF receiver and the IC-R100 multipurpose receiver.

IC-R1. The smallest wideband handheld available today, the IC-R1 continuously covers 100kHz - 1300MHz (Specifications Guaranteed 2-905MHz) with AM, FM and Wide FM modes. This tiny receiver measures just 241mmW x 94mmH x 229mmD.

Easy operation is a snap with the IC-R1's Dual Frequency Selection (direct keyboard and rotary tuning). 100 memories and a 24-hour clock completes the world's smallest full-featured handheld receiver.

IC-R100. Install the IC-R100 at home or in your car. Listening pleasure is guaranteed with continuous coverage from 100kHz-1856MHz (Specification Guaranteed 500kHz - 1800MHz) in AM, FM and wide FM modes. Monitor VHF air and marine bands, emergency services, government as well as amateur stations. 121 fully programmable memory channels, multiple scanning system, an automatic noise limiter, built-in preamplifier and attenuator, clock with timer, and built-in backup lithium battery make the IC-R100 the perfect package for mobiling or base operation.

IC-R72. The IC-R72 continuously receives 100kHz - 30MHz in SSB, AM and CW modes with very high sensitivity. An optional UI-8 provides FM reception. Additional features include: Noise blanker, five scanning systems, AC/DC operation, internal backup battery, built-in clock and ICOM's DDS System. The IC-R72 boasts a 100dB wide dynamic range while an easy-to-access keyboard provides convenient programming versatility. The easy to operate IC-R72 is superb for short wave listeners.

The IC-R1, IC-R72 and IC-R100 join ICOM's current line of professional quality receivers. . . the IC-R71A, IC-R7000 and IC-R9000. ICOM. . . expanding the horizons to bring you better technology, today. See the complete line of quality ICOM receivers at your local authorized ICOM dealer today.

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READER INFO NO. 24

WORKSTATION

EA'S COMPUTING SUPPLEMENT

COMPUTER VIRUSES: HOW THEY WORK, HOW TO STOP THEM

BOARD & PROGRAM CONVERT PC INTO PROGRAMMABLE LOGIC CONTROL

FASTER PLOTTING WITH HP 7550 PLUS

Computer viruses and how to stop them

Here's a guide to the viruses, trojan horses, and other antisocial 'nasties' now spreading through personal computers at increasing speed. It describes what they are, how they operate, how to cure an infection and how you can protect your computer(s) against acquiring them. The author is an acknowledged expert on this subject.

by ROGER RIORDAN, B.E.E. (Melb.), SMIREE

Twenty four years ago, when I started programming, CSIRO's computer resided in a temple guarded by a heirachy of priests and acolytes. We mere users were treated with disdain. If we grovelled sufficiently the guardians might consent to accept our pack of cards and feed it to the oracle. Hours later we would get it back with a listing, and as often as not this would complain of some trivial error on card two, and then turn out to have aborted the job.

Years later, the arrival of the PC freed us from the tyranny of the EDP manager, and we could enjoy the thrill of having our very own computer, to use as and when we wished. Even more wonderful was the discovery that the open architecture of the PC enabled us to modify it to suit our own requirements, and gave us access to a wealth of nifty utilities from around the world.

But unfortunately mischievous programmers soon realised that this flexibility could be misused, and anti-social software started to appear. At first this was relatively harmless, but a vindictive streak soon appeared, and nowadays there is some appallingly destructive software around. I fear that the wheel is likely to turn full circle, as the anarchy which has developed from the idealism of the early days of the PC will inevitably hasten the development of more secure, but less friendly operating systems. Before long people will look back with nostalgia to the golden age of the 80's, when you could safely run any program you were given (or at any rate you could assume that the author had not deliberately set out to destroy your hard disk!).

In this article I will define the various types of anti-social software, then describe how viruses spread and what they do, and finally I will outline how you can defend yourself from them.

'Anti-social' software can be divided into four broad categories:

(1) **JOKE PROGRAMS** These are programs which you load into some unsuspecting victim's computer. They are usually activated by a command hidden in the file AUTOEXEC.BAT (which is run when you switch on your PC), and after a delay simulate some bizarre malfunction, or threaten to do something disastrous. It wouldn't surprise me if someone had had a heart attack as a result, or lost data when they panicked, but the programs don't actually do anything destructive.

(2) **TROJAN HORSES**, which trick the victim into running them, and then do something destructive. They usually 'appear' on bulletin boards, with a file promising some marvellous effect, such as 'streamlining your hard disk' (by erasing all the files!). Joke programs and Trojan Horses are both spread by human action, and differ only in intent.

(3) **VIRUSES**, programs which spread without human intervention, by attaching themselves to — or infecting — programs which are likely to be copied from computer to computer. They can only become active, and infect other programs, when an infected program is run.

(4) **WORMS**. These are programs which can propagate and spread through a network of computers without any assistance. They require a large network of multitasking computers to propagate effectively, and so far have been largely confined to the various UNIX networks.

Viruses are divided into two broad groups, according to the type of program they infect. The first group are the *boot sector viruses*.

In the business world most disks only have data on them, so at first glance you might think they could not spread viruses. But *every* disk has a boot sector, and if a disk is in drive A when you turn the computer on, or hit 'Control-Alt-Delete', or you get a power glitch, or sometimes if a program crashes, the hardware will load the disk's boot sector, and attempt to execute it. If the disk has been infected by a virus it will infect the computer, whether or not it is a 'Boot Disk'.

Many victims of viruses swear that they never boot from floppies, but when I show them the message 'NOT A BOOT DISK, REPLACE AND STRIKE ANY KEY' they admit that it is not the first time they have seen it. Every time you see this message you could have got a virus, if you do not know that all your disks are clean. Many users, caught like this, have had viruses for months, and have only discovered this when they gave a disk to a friend, or their system has crashed for some reason.

Boot sector viruses hide the original boot sector somewhere else on the disk, often accompanied by the main part of the virus, and put part or all of the virus in its place. Then if you boot from the disk the virus installs itself in the computer, usually at the top of the normal memory. It usually checks the hard disk, to see if it is already infected, and if not infects it. Then it loads the original boot sector and attempts to run it. If the system files are present the computer will boot normally, otherwise it will give the normal diagnostic message.

When the virus infects a disk it may either look for an unused block on the disk, mark it 'bad' so DOS will not try to use it, and put the original boot sec-

tor in it; or it may simply hide the boot sector in a place where it is relatively inconspicuous. Thus on 360K floppies the 'Stoned' virus hides itself at the end of the *root directory*, overwriting the last 36 entries. This will only be noticed if there are more than 96 entries in the directory. However on high density disks it plonks the boot sector smack in the middle of the directory and this will often cause files to be lost.

The 'Yale' virus overwrites the very last sector on side zero, and will only destroy data if this is being used, while the 'Ohio' or 'Den Zuck' virus writes an extra track inside the normal last track. Here it is safe from prying eyes, and cannot destroy data, but the virus is not copied by DISKCOPY.

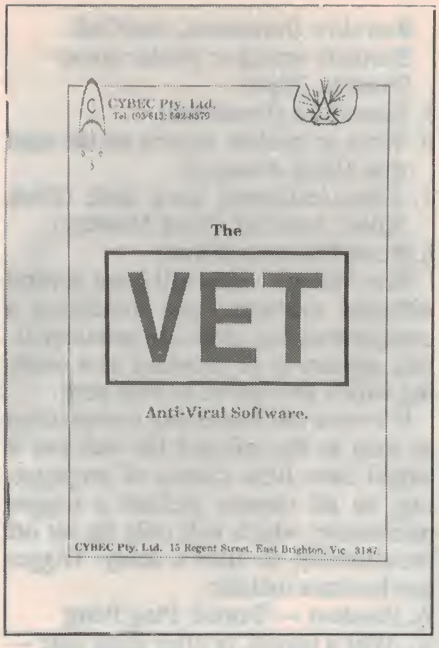
If a virus infects a disk already infected with another virus, it hides the existing virus and installs itself in the boot sector. Then each virus will become active if you boot from the disk, and each will infect every disk put in the computer — even if it is already infected. If one of the viruses uses a fixed hiding place, and infects a disk twice, it will become impossible to boot from the disk, as each virus will load the other in an endless loop.

Booting from a hard disk is a more complex procedure, and provides more opportunities for a virus. When you turn on the PC the BIOS (*basic input-output system*, which is a program permanently stored in the PC in ROM — read only memory) first tries to load a boot sector from drive A. If there is no disk in the drive, the BIOS then loads sector 1, head 0, cylinder 0 of the hard disk into memory.

I usually refer to this sector as the BIOS boot sector. It contains the *partition table*, which specifies how the disk is divided up, and which is the *active* partition (i.e., the one to boot from), and a short program which deciphers the table, and loads the boot sector of the active partition.

I refer to this second boot sector as the DOS boot sector. Apart from the data specifying the size of the partition, it is normally identical with the boot sector on your floppies. In IBM PCs, and most clones, the DOS boot sector is in sector 1, head 1, cylinder 0, and the rest of the track accessed by head 0 is unused.

A boot sector virus can occupy *either* of these boot sectors on the hard disk. Most boot sector viruses replace the DOS boot sector, and usually occupy unused sectors, which they mark as 'bad'. However the 'Stoned' virus



The manual which accompanies 'VET', the author's Australian written anti-virus package.

occupies the BIOS boot sector, and hides the original in the following unused space. Unfortunately in some clones this contains the *file allocation table* or 'FAT', which specifies where files are stored, and which parts of the disk are in use. At Chisholm Institute we had a lab full of such PCs, and when they were invaded by the 'Stoned' virus the lab became completely unusable.

Program viruses

Program viruses infect executable files (programs, games, etc). They may infect .COM files, .EXE files, or usually both, while some also infect other executable files such as .SYS, .BIN, .PIF or .OVL. When you run an infected program the embedded virus hides itself in memory, and then watches what is going on. Some actively search the hard disk for files to infect, but this is rather obvious, so most wait till you ask DOS to load a program. They check the file, and if it is not already infected they infect it. Then they pass the original request on to DOS. Most only infect files which are loaded and executed, but some check every file opened, and infect any .COM or .EXE. These viruses often avoid COMMAND.COM, and some avoid short files.

Most program viruses save the original date, time and attributes, and restore them when they have finished. Marking a file as READ ONLY has no effect on most viruses.

When an infected program is run the virus must first find somewhere to hide itself. Then it must modify the operating system in some way, so that it can keep an eye on what is happening, and finally it must run the original program.

Some viruses move themselves to the bottom of free memory, load and run the original program, and then use the DOS function call Int 21h Fn 31h (Terminate & Stay Resident) to return control to DOS. Others trace the memory allocation chain and install themselves at the top of memory. These can usually be detected because the top of memory is lower than usual. A few viruses simply move themselves to the top of memory, without doing anything to protect themselves. The system will crash when another program overwrites them, but their writers apparently assume that by then they will have infected enough new files to survive.

Programs normally communicate with the operating system by issuing *software interrupts*. These are a special type of function call which finds the address of the function it is calling from the *interrupt vector table* at the very start of the PC's memory.

The only approved way to talk to the system is via INT 21h, the normal DOS function call. This provides a wide range of services, depending on the parameters previously loaded into various registers. DOS uses several other interrupts for various purposes. The main ones are:

Int 21h Normal DOS function call

Int 23h Control Break Handler. Called if Ctrl-break pressed.

Int 24h Critical Error Handler. Called if you try to write to a write protected disk, etc.

Int 25h Absolute Disk Read. Read a specified sector(s) into memory.

Int 26h Absolute Disk Write. Write to a specified sector.

Unfortunately DOS is often slow, and cannot perform many essential functions, so many programs use other interrupts which communicate directly with the BIOS. This is a much lower level set of functions, permanently stored in ROM, which actually do the 'dirty' work. Most calls to DOS generate further calls to the BIOS.

Some important BIOS calls are:

INT 9h Keyboard service. Issued whenever a key changes status.

Int 10h Video I/O. Used to write to the screen.

Int 13h Disk I/O. Read from, write to,

or initialise either a floppy or hard disk.

Int 16h Keyboard I/O. Read keyboard status, or fetch a key.

Int 1Ch Timer tick. Called 18.2 times/sec.

When you ask a program to read a file, it issues an Int 21h, function 3Fh to DOS. DOS decides which absolute sectors hold the file, and uses Int 25h to call a lower level part of DOS. This in turn uses Int 13h to call the BIOS, and after several more steps the BIOS uses IN and OUT instructions to an I/O PORT to tell the disk controller which physical sector to read, to get the data you want.

When a boot sector virus installs itself, DOS is not loaded — so it can only use the BIOS. But a program virus can communicate with the system at any level. Some only use standard DOS calls, some use Int 25h and Int 26h, some use Int 13h, and a few write directly to the I/O ports.

Most viruses maintain control of the system by *redirecting* some of these interrupts. This means that they save the address which is in the Interrupt Vector Table, and replace it with the address of a function in the virus. Thus, if a virus redirects Int 13, every time DOS (or anything else) issues an Int 13 the virus can see what is being done. If it is not interested it can pass the call on to the original function; or it can do something first, or it can fake a response.

For example if the 'Brain' virus sees that a boot sector is being read, it will first examine it. If the disk is not infected it will infect it, then it will read the good boot sector from its hiding place and return that, so that as long as the virus is in control the infected boot sector cannot be detected or replaced.

Warheads

The first virus writers were content with proving that they could write a virus. But they soon became more ambitious, and made the virus do something to show that they had succeeded. It might:

1. Issue a taunt: 'Your PC is now stoned.' (Marijuana)
2. Play a tune: Yankee Doodle (AntiCad)
3. Cause some amusing (for bystanders!) effect:
   Bouncing ball (Ping Pong)
   Falling letters (Cascade)
4. Make the computer misbehave:
   Run slow (Jerusalem, AntiCad)
   Simulate typing or printer errors (Fumble, Typo)
5. Erase files (Jerusalem)
6. Write to random sectors on the hard disk (Dark Avenger)
7. Erase/reformat hard disk (Disk Killer, AntiCad, Black Monday)
8. Reset file dates (Slow)

Very often a virus will have several different warheads, and sometimes a conspicuous but relatively harmless effect appears to be provided as a warning which you ignore at your peril.

If a virus did something conspicuous as soon as the infected file was run it would have little chance of propagating, so all viruses include a trigger mechanism which will only be set off occasionally, or after a delay. Trigger mechanisms include:

A. Random — Stoned, Ping Pong
B. After a period, or after some date — Slow, AntiCad
C. On specified date(s) — 4096, Jerusalem
D. If you try to kill it — AntiCad.

Some viruses are relatively easy to detect, but others go to great lengths to hide themselves. These are referred to as *stealth* viruses. For example the '4096' virus redirects interrupts without modifing the interrupt table, and disinfects files before it lets you see them, so that scanners cannot detect infected files while it is active.

Viral symptoms

Apart from the immediately recognisable effects like funny messages or tunes, there are a number of symptoms which can indicate that you have caught a virus. These include:

1. **Excessive disk activity.** If a virus is active, and you run a program from a floppy the virus will usually try to infect the disk, and if the disk is write-protected the 'grinding', as the virus repeatedly attempts to write to the disk, is very obvious. The effect is even more obvious if you fit your hard disk with a write-protect switch, and then run a program which should not write to the disk.
2. **Computer running slow** (Jerusalem, AntiCad).
3. **Files increase in length** — all program viruses. The Jerusalem virus repeatedly infects .EXE files, so that they grow until they will no longer fit in memory.
4. **Programs crash.** Jerusalem kills many large packages.
5. **Apparent hardware problems** (e.g. Typo, Fumble).
6. **Incompatibility problems.** Viruses use the 'back door' to access the system, and will inevitably cause crashes when they interfere with other programs (especially TSR's) or viruses also using the back door.
7. **Unusable backups.** Many backup programs (such as PCTools' *PCBackup*) use non-standard disk layouts, and if a virus is active when they are run the backup disks are likely to be useless. If you have a virus use XCOPY to make a copy of any irreplaceable files before you try to remove the virus.

Unfortunately viruses are a godsend to the incompetent serviceman, as it is all too easy to blame an obscure problem on a virus. But there is a plague of unreliable software on the market, and disk drives are mechanical devices, and will inevitably fail eventually; so if files get scrambled, or disappear, or a particular package crashes regularly, the cause is more likely to be a bug or a mechanical problem than a virus.

No virus has been reported that can cause mechanical damage, so if you are told (as one lady was) that your disk controller burnt out because your PC had a virus, you know the speaker is incompetent.

Naming viruses

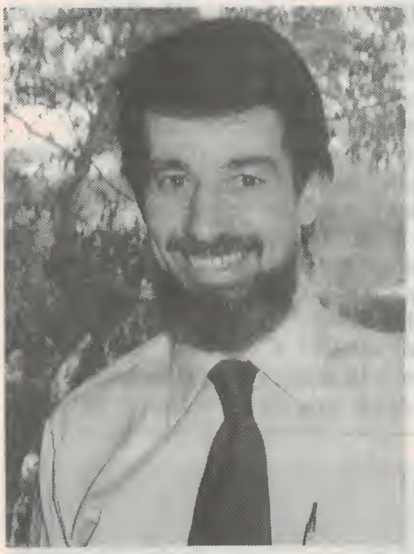
Some viruses announce their own name, and others are named for their effect. But often several workers will get a new virus at the same time, and each will name it, so most viruses have several names.

There are about 25 viruses known to be active in Australia. Some of the more common ones are:

1. **Stoned, or Marijuana**: Boot sector/partition table. Overwrites part of directory on floppies, FAT on PCs with non standard partitioning. Very common in schools, shops, etc. Will not propagate on many recent PCs. Displays 'Your PC is now stoned.' message occasionally when you boot from an infected floppy. This was the first virus to receive wide publicity in Australia, and is believed to have been written in New Zealand.
2. **Brain/Pakistani**: Boot sector, floppies only. Marks bad cluster, changes volume label to '(C) Brain', otherwise relatively harmless. Cannot infect 286/386 PCs. One of first viruses seen.
3. **Ping Pong/Italian**: Boot sector, marks bad cluster. Bouncing ball display if disk access on half hour. Cannot infect 286/386 PCs.

4. **Computer Ogre**: Boot sector, marks bad cluster. Formats hard disk if PC left on for 48 hours. Has bug, and often puts virus in wrong place, so may kill program, but may also activate prematurely. Often does not work, but don't rely on it!
5. **4096/Frodo**: Very sophisticated. Infects every .COM, .EXE file opened, increases file size by 4096 bytes, but hides changes to files from scanners while it is active. Has a number of tricks to elude watchdog programs. Intended to corrupt the hard disk if run between Sept 22 and Dec 31st, but has a bug, and just crashes the system.
6. **AntiCad/Plastique/Taiwan3, 3a series**: This family infect every .COM, .EXE opened, adding various lengths. All play a tune every 10 minutes or so. The warhead is triggered if you hit 'Ctrl-Alt-Del' while the tune is playing, or if you try to open ACAD.EXE. The virus overwrites some or all tracks on drives A-D, then destroys the setup information in the CMOS RAM. One version also infects boot sectors on both floppy and hard disks, while the others disable all disk writes if you hit 2000 keys without accessing the disk. Three versions have been seen here, with several more overseas.
7. **Black Monday**: Infects .COM & .EXE, adding 1055 bytes. The fourth time an infected file is run in a PC which is not already infected on any Monday, the first 255 tracks of the hard disk are reformatted.
8. **Dark Avenger**: Infects every .COM, .EXE file opened, adds 1800 bytes. Spread by scanners, if they do not first check for it in memory. Randomly writes a sector to a random address on the hard disk, so data slowly corrupted. If you back up regularly, but recycle a small number of disks all backups may be corrupted by the time you notice something is wrong.
9. **Jerusalem**: Infects any file loaded and executed, adds 1813 bytes. Slows PC down, scrolls section of screen up after half hour. Erases any file run on any Friday 13th. Interferes with Novell networks.
10. **Sydney/Slow**: Infects .COM, .EXE files, adds 1721 or 1716 bytes. Occasionally spawns mutant child with new signature. In 1991, and thereafter, sets date and time of every second file closed on any Friday to midnight 1.1.80, apparently to confuse accounting packages and automatic backup procedures.
11. **St Leos/Keylock**: Infects .COM, .EXE, adding 1232 or 1472 bytes. Every 10 minutes it activates for about two seconds, and any key hit during this period will repeat many times. Usually the keyboard locks up after a while. First copy found on game from Indonesia, now common in several schools in Melbourne.

About the author



Roger Riordan was born at Ivanhoe, Victoria, in 1934. He graduated in Electrical Engineering from Melbourne University in 1954, and after two years in England, joined the CSIRO Division of Mechanical Engineering at Highett, where he worked on circuit theory and design. In 1968 he described the first high performance gyrator using op-amps. This circuit is now generally known as 'Riordan's Gyrator'.

Mr Riordan first became involved with computers in 1967, when he started to write a program ALEC, for the analysis of electronic circuits. ALEC was written in Fortran, and was usually compiled and run on the CSIRO's CDC 3600 in Canberra. The program was submitted on cards, which were taken by courier to Clayton, transferred to magnetic tape, and flown to Canberra. The tapes were run overnight, and the results were flown back to Clayton on tape, listed there, and returned by courier the next day (if there wasn't fog in Canberra!). The most trivial change would take a week to debug. The CDC 3600, which cost a fortune, and had an army of operators, had 64K of 48-bit words of memory, and could do a floating point multiplication in about a microsecond.

In 1973 Mr Riordan resigned from CSIRO to form CYBEC Electronics. In 1983 he joined the Chisholm Institute of Technology (at Caulfield), as a Lecturer in the Department of Electrical Engineering, and specialised in instrumentation and assembly language programming. He wrote the first version of VET early in 1989, and resigned at the end of the year to work on it full time. He is now Technical Manager of CYBEC Pty Ltd.

Mr Riordan has published a number of technical papers, mostly relating to circuit theory and design, and has been granted several patents.

Anti-viral software

A wide range of anti-viral software is available. This uses four main techniques, although most packages combine several of them.

SCANNERS search files looking for distinctive patterns associated with known viruses. They may erase infected files, or they may remove the virus from the file, so that it can be used without having to re-install the package.

Scanners give excellent protection against known viruses, but they are always a bit behind the play, as they cannot detect a virus until it has been captured and analysed. Scanners will spread certain viruses (such as 4096) if they are active, so the scanner must search memory for viruses before it examines any files. Scanners will not interfere with the normal operation of the PC, but require the operators to be trained to use them. There are also resident scanners which automatically check every program before it is loaded. These save the user from having to worry about scanning disks, but take up memory, slow down loading, and may interfere with other software.

WATCHDOG PROGRAMS are TSR programs which monitor various interrupts, etc, and watch for suspicious or potentially damaging requests. Unfortunately many legitimate programs do suspicious things, while viruses can damage files without accessing interrupts at all, so watchdog programs give limited protection, but cause many false alarms. Most users fairly

soon get fed up with them and turn them off. However they are useful to a skilled user testing unknown software, and do give some protection against trojan horses.

Certain viruses issue calls to INT 21h with undefined parameter values to check if they are already active, and a watchdog program which only checks for these function calls is very effective against these viruses. The program can be short, and is less likely to generate false alarms. However a few applications use these function calls for their own purposes, and will be terminated by these programs.

The most common problem occurs with Novell networks, which use the identification call of the Jerusalem virus for print spooling. This type of program is very useful on PCs used by students.

INOCULATION PROGRAMS operate by making a harmless change to a file (or boot sector), which can fool some viruses into thinking that the file is already infected. For example the 'Vienna' virus sets the 'seconds' field in the file directory to 62, so if you deliberately do this to all the files on your hard disk the virus will not infect any of them. Inoculation programs are available for a number of viruses, and if a large organisation has had an outbreak of a virus, inoculation against it may be worthwhile to reduce the likelihood of secondary outbreaks.

SIGNATURE RECORDERS operate by calculating 'signatures' for selected files on the hard disk, the first time these programs are run. They then store them away. Every time they are subsequently run they recalculate the signatures, and compare them with the recorded values. These programs have a good chance of detecting unknown viruses before they do any damage, but they require some skill to install. They can be fooled by 'stealth' viruses, so ideally the PC should be booted from a clean disk *before* they are run.

Many suppliers provide packages including scanners, cleaners, monitors, and so on.

Hardware protection against viruses is also feasible. It is relatively simple to fit a write-protect switch to the hard disk in most PCs, and this is very useful for protecting the hard disk while testing new or suspect software.

It is also possible to modify the BIOS ROM so that the PC does not try to boot from drive A — but this is a job for an expert.

Recovering from a virus

If you get a virus it is important to get rid of it quickly; but DON'T PANIC. Boot your PC from a clean DOS disk, and copy off all important files. Do not assume that you have a good backup — if your backup is no good, you will never know until it is too late. Then seek expert advice.

If you rush in and reformat your hard disk you will not get rid of 'Marijuana', but it will take you hours to replace everything, and you will probably find you have forgotten to back up something important. On the other hand a good anti-viral program will remove it in a few minutes, and you will usually not lose anything.

After you have 'cleaned up' your PC(s) you will have to clean up all your disks. If you have had a virus for any time many of them will be infected, and if you miss a single infected disk you could get the virus again. So get some little sticky labels, and mark each disk as you check it. Go through all your disk boxes, drawers and dark holes, and check every disk you can find.

If you have had Marijuana, you will have to check all your disks to see if you have lost any files (they can usually be recovered fairly easily if they are important), and if you have had a program virus (especially Jerusalem) you should check all the files that were infected to make sure they still work.

Good housekeeping

Keeping your PC 'clean' is largely a matter of good housekeeping. If you apply the following rules conscientiously, you are relatively unlikely to have serious problems with viruses.

1. Adopt reliable backup procedures, using an adequate number of copies, and keep a copy of all critical data off site. You are far more likely to lose data through mechanical failure, fire, theft or sabotage, than from viruses.
2. Install reliable software on ALL your PCs, and make certain everyone knows how to use it.
3. Check EVERY disk which has been in any other PC.
4. Write-protect any disk containing programs which you will use in anyone else's PC. Salesmen and servicemen are two of the worst offenders at spreading viruses.
5. Format all your data disks on a known PC. If you have to use a suspect PC check all the disks used, and replace any unknown boot sectors.
6. When you get new software, from ANY source, check that the disks are write-protected, BEFORE you do anything else, then scan them for viruses. If you find any viruses, notify the vendor. If you want to use the program anyway copy the disk, and clean up the copy.
7. Check all your PCs regularly, and if you write software check all your disks before you send them out.
8. Keep at least one PC for games, testing unknown software, etc. It is impossible to stop your employees from playing games and swapping software, so it is much better to let them do it under supervision than have it done behind your back. It is also wise to provide all staff who

use PCs at home with anti-viral software so that they can catch their children's viruses before they bring them to work.

The VET package

When the 'Stoned' virus overwhelmed us at Chisholm Institute, no-one knew anything about it. The limited software we could find to combat it did not seem to be suitable for a student environment, and was far too expensive for our limited budget. So we wrote the program VET to remove it. This was given to the students as shareware, and quickly spread throughout Australia.

VET is no longer shareware, but it has been progressively updated and will find and remove all the viruses known to be in Australia. It does not find the many exotic viruses found by overseas packages, but it is faster and easier to use and will recover files infected with common viruses which other packages can only delete.

The VET package includes the Watchdog program VET_STOP, which will prevent many of the common dangerous viruses from infecting your PC. It is available from the author's company CYBEC Pty Ltd, PO Box 82, Hampton, Victoria 3188; phone (03) 521 0655.

Other software

Other anti-viral software that can be recommended includes the following packages:

1. **VIRUSCAN, CLEAN, SENTINAL**: VIRUSCAN detects over 200 viruses. CLEAN will remove some viruses from files, but not some that are fairly common here. Available from McAfee Associates, 4423 Cheeney Street, Santa Clara, CA 95054 USA; phone (0011 1 408) 988 3832, bulletin board (408) 988 4004.
2. **FLUSHOT+**: A well-known Watchdog program, available from Ross M Greenberg, Software Concepts Design, 594 Third Avenue, New York NY 10016 USA.
3. **DR SOLOMON'S ANTI-VIRAL TOOLKIT**: Incorporates scanner, cleanup, inoculation programs and utilities. The Scanner will detect over 200 viruses. Available from S&S Enterprises (Amersham) Ltd, Weylands Court, Water Meadow, Germain Street, Chesham, Bucks HP5 1LP UK; phone (0494) 791 900. ■

ENHANCEMENT PRODUCTS FOR PCs

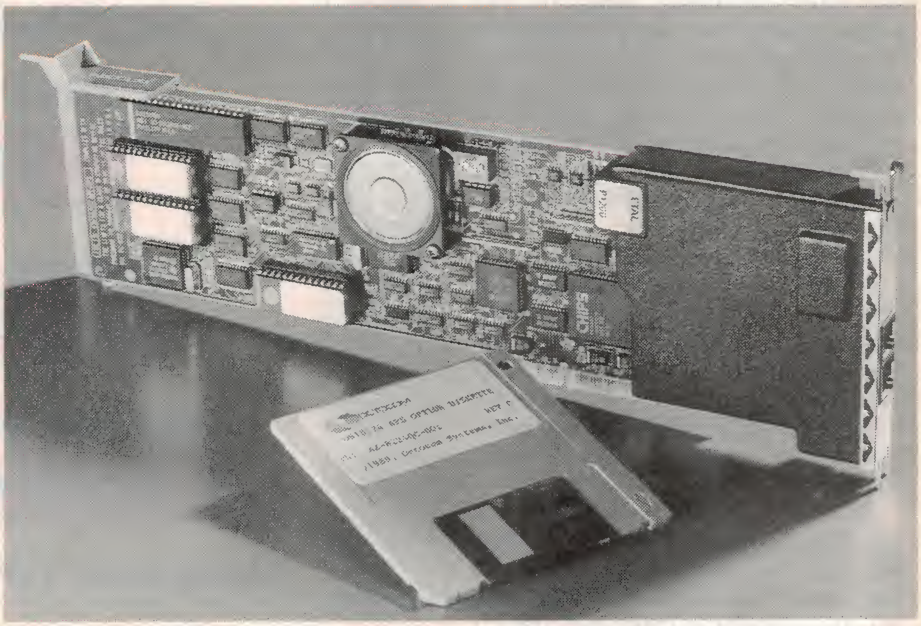
PS/2 compatible internal modem

Dataplex's reliable quad modem, the DPX-224, is now available in card form for direct installation in a Micro Channel Architecture card slot of the IBM PS/2.

This new modem, the OSI-8224PS, supports async operations at 2400, 1200, 1275 and 300bps using CCITT V.22bis, V.22, V.23 and V.21 standards. Its features include auto answer/auto dial and can be configured using Hayes AT commands or the CCITT V.25bis command set.

The modem retails at $1040 tax free and $1196 tax paid.

For more information, circle170 on the Reader Services Coupon or contact Dataplex, 7-9 John St, Lilydale 3140; phone (008) 033260.



386SX upgrade

Australian PC enhancement board builder Hypertec has announced two new Hyper 386SX upgrade boards, bringing to four the number of versions available.

This means that even more 286-based computers can be inexpensively upgraded to take advantage of 386-based processing such as Windows 3.0, Xenix and the latest version of Lotus.

Hyper 386SX is a credit-card sized board which fits directly into the processor slot of an 80286 machine after removing the 80286 chip.

Once installed, it gives full code compatibility with all the latest 80386-based software, while retaining full compatibility with existing 80286 software and hardware.

Four different configurations of the Hyper 386SX chip have been produced to allow it to fit into the widest range of machines. All versions are priced at $595 ex tax and carry a 24 month warranty.

For more information, circle 171 .. on the Reader Services Coupon or contact Hypertec direct; phone (02) 816 1211.

Compression of still images

Digithurst of the UK has announced its new MicroEye image compression card for PC compatible computer systems, providing a practical and inexpensive solution to image storage problems.

The card works as a standalone image compressor for use in any PC-based system, and is supplied with utility software for this purpose.

The default compression ratio is typically 30:1, reducing a 1MB 24-bit colour TIF image to approximately 30kB, allowing 40 images to be stored on a standard 1.2MB floppy disk.

Compression and decompression time for a 1MB image is about 15 seconds and reduces proportionately for smaller images. Compression ratios adjusted in software from 3:1 to 100:1, trading off image quality for file size.

Aside from storage space advantages, the Microeye card offers significant speed benefits when loading from and saving to disk, as well as cost savings when transmitting image data.

For more information, circle 172 on the Reader Services Coupon or contact Dindima Group, PO Box 106, Vermont 3133; phone (03) 873 4455.

12-bit A/D card

Strawberry Tree has announced a new totally software setup series of high speed data acquisition cards for IBM PC and compatible computers. The Flash-12 series is designed for transient recording, vibration, aviation, automotive, audio and other high speed data recording. They can be used for background data acquisition, at rates as fast as one million samples per second to as slow as one sample every 1.5 days.A wide range of triggering options is available and sample rates may be different on each channel. Low level and low speed signals such as thermocouples and pressure sensors can be sampled along with high speed signals.

With an optional daughter card, two channels of buffered 12-bit analog output can be used to synthesize waveforms. The cards work seamlessly with Strawberry Tree's WorkbenchPC icon-based graphics software for easy setup of complex applications such as digital storage scope emulation, data logging and control.

For more information, circle 178 on the Reader Services Coupon or contact APC, PO Box 584, Bayswater 3153; phone (03) 720 3298.

Internal modem for Toshiba laptops

Dataplex is now marketing and supporting the Worldport 2496iT Fax/Data modem. The 2496iT combines a 9600bps Group III facsimile with a 2400bps data modem and is an internal product designed specifically for Toshiba laptops. Major features include automatic inbound fax/data recognition, express send with integrated word processor, cover sheet function, menu driven software, bulletin board system, group broadcasts and delayed transmissions.

There is also a telephone directory combining both fax and data, and an acoustic coupler interface.

For more information, circle 174 on the Reader Services Coupon or contact Dataplex, PO Box 541, Lilydale 3140; phone (03) 735 3333.

Display controller for PC/AT

Univision Technologies has introduced the UDC-7000-TI which is a single board graphics controller for AT-based systems based on the new TI34020 chip. The UDC-7000-TI can display images as large as 1280 x 1024 x 32 bits, from a display memory of 2048 x 2048. This feature is very important in applications such as seismology where full 24- bit colour and 8-bit graphic overlays are required.

In addition, the on-board 33 MFLOP co-processor, 20 MHz peripheral bus and local pan and zoom hardware allow a single add-in board to handle demanding imaging and graphic applications at up to 32 bits/pixel. Graphic support allows programs like Microsoft Windows, CADKEY, AutoCAD and HALO to run without modification.

For more information, circle 173 on the Reader Services Coupon or contact the Dindima Group, PO Box 106, Vermont 3133; phone (03) 873 4455.

Low cost LAN card

Datacraft has produced a new low cost LAN card, the CS450, to allow PC users to connect with previously incompatible host systems. Based on the Motorola 68000 processor, it runs at 12.5MHz. The card connects in any PC with an XT/AT expansion slot, and provides interconnection between numerous protocols and environments. Because this full length, inexpensive card performs most functions, PC processor time not degraded. The PC can be standalone or networked; in a LAN environment, up to 32 PC users can access the host system concurrently, with file transfer and Hot-Key options.

For more information, circle 175 on the Reader Services Coupon or contact Datacraft, PO Box 353, Croydon 3136; phone (03) 727 9176.

Programmable scanning interface

Univision Technologies offers its model UPX-1000-AT, which is a board-level product which occupies an auxiliary slot in an IBM PC/AT or compatible. It interfaces high resolution digital scanners to Univision display controllers and accepts digital video inputs from scanners and digital video cameras such as the Videk Megaplus Camera.

The UPS-1000-AT supports these inputs at transfer rates of up to 10 million (8-bit) pixels per second at a 10MHz clock rate. A 1340 x 1136 x 8-bit image is acquired at approximately 7.5 frames per second. 8-bit and 16-bit transfers are supported.

For more information, circle 176 on the Reader Services Coupon or contact the Dindima Group, PO Box 106, Vermont 3133; phone (03) 873 4455. ■

PC Enhancement Product:

Boards & software convert PC to a PLC

Melbourne firm Procon Technology has for some time been marketing its range of rugged Australian-designed and manufactured I/O cards, to interface between a PC and the 'real world' of relays, motors, heaters, switches and sensors. Now the firm has developed a matching software package, which goes with the cards to convert the PC into a powerful yet easy to use programmable logic controller.

by JIM ROWE

Back in the old pre-microprocessor days, a logic controller was usually a box with a collection of hard-wired relays, designed to perform a fixed and fairly simple sequence of electrical monitoring and control functions. If switch contacts A and B closed at the same time, relay 1 was energised to turn on (say) a motor; if contacts C then opened, relay 2 would be energised after 5 seconds to turn on a heating element; and so on.

This type of logic controller was simple, low in cost and fairly reliable. But it had one major shortcoming: if you wanted to change its control sequence, this generally involved either rebuilding or replacing the controller hardware.

When microprocessors came on the scene, this limitation soon became a thing of the past. By replacing the logic controller's internal hard wiring with a micro running a firmware program stored in a PROM, it could be arranged to respond in any desired way to various combinations of inputs, and control the desired outputs. And the response pattern could be changed or modified at any time, simply by changing the program in the PROM. The programmable logic controller or 'PLC' was born.

PLC's are much more flexible and 'intelligent' than the old relay controllers, and they're generally more reliable as well. But many of them are quite expensive, and often they can only be programmed in a fairly esoteric and specialised language.

Now essentially a PLC is just a microcomputer with a set of inputs and outputs to connect it to 'real-world' relays and switch contacts, and running a suitable program. So it was understandable that with the cost of IBM-compatible PC's coming down all the time, people in industry started to wonder if a low-cost PC clone couldn't be pressed into service, as the heart of a simple (or even not-so-simple) PLC. Presumably all you'd need, they reasoned, was the right interfacing circuitry — suitably isolated, to protect the PC from possible damage — and an appropriate PLC emulation program. Why, you might even be able to write the program in a simple language like BASIC...

New applications

Of course there's no reason at all why this can't be done. A PC can be used to make a very practical PLC, and often for a lot lower cost than a dedicated industrial PLC. Which opens up applications of PLCs in all sorts of areas, formerly regarded as too modest to justify the cost of using them.

For example they can now be used in home and business security systems, for industrial process control in small and impecunious companies, to automate laboratory experiments, to automate quality control and equipment testing, and even for 'hobby control' applications like automating a model train layout or controlling a garden watering system.

All that's needed, for most of these applications, is to provide the PC with the right interface and software.

For a couple of years now, Melbourne firm Procon Technology has been marketing a range of I/O interfacing cards for this very purpose. Designed and manufactured at the company's plant in Mount Waverley, the boards are solidly made and intended to connect up externally to a standard PC (or a dedicated micro), via a parallel printer port. They then provide a set of isolated inputs and outputs, to allow the PC to sense the status of, and also control external devices.

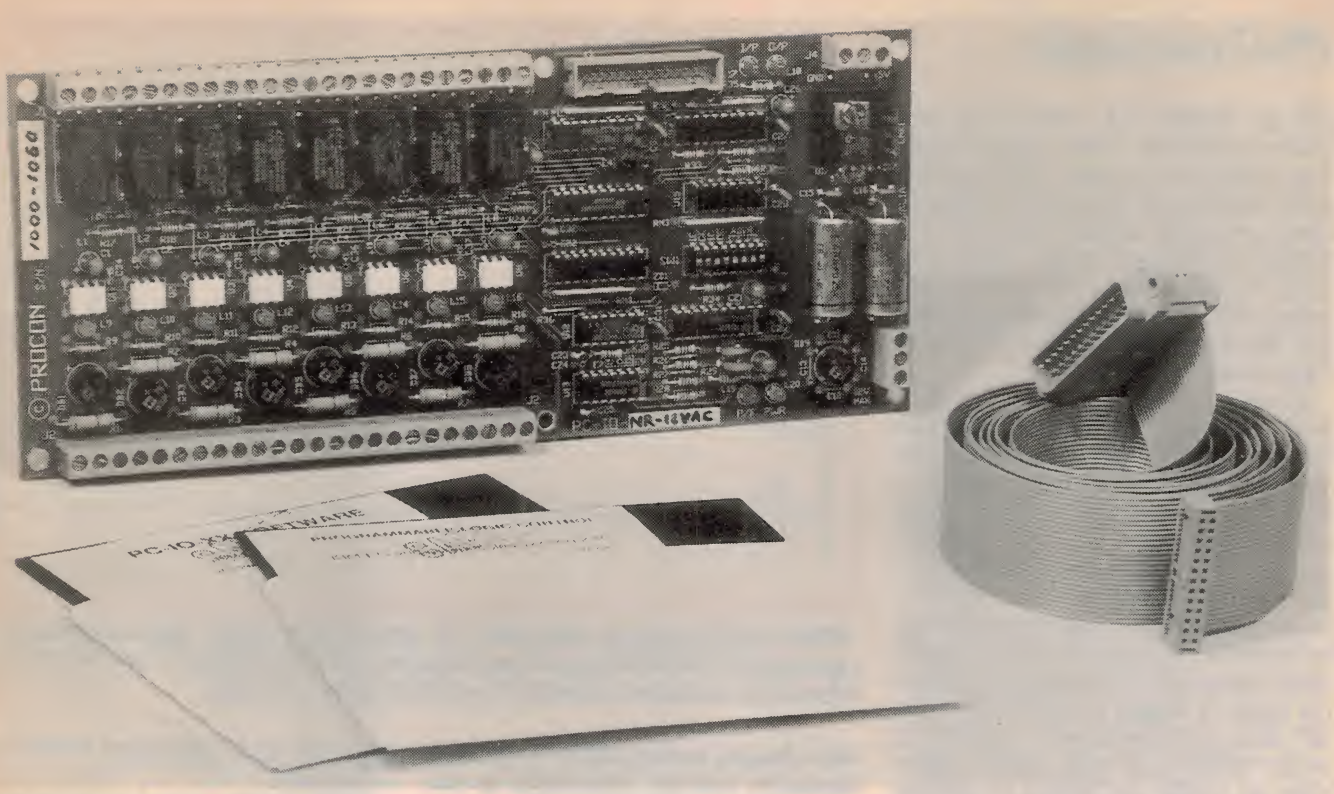
Isolated inputs, outputs

An example of the Procon range is the PC-IO-NR board, which provides eight 24V nominal (10mA) DC/AC digital inputs, each fitted with optocouplers for isolation rated at 1000V RMS. It also provides eight outputs, each with an isolating relay fitted with SPDT contacts rated at 110V AC/30V DC and 0.3A AC/1A DC.

The PC-IO-NR is also provided with a set of DIP switches, which are used to give each board a unique address. This allows up to seven boards to be connected to a single printer port, or as many as 15 boards to a slightly modified port, to achieve up to 120 isolated inputs and outputs.

Other features of the board include built-in contact debouncing and filtering on the inputs; a set of LEDs to indicate the status of the individual inputs and outputs, as well as the status of the board itself; a 'fail safe' design, which ensures that faults generally cause outputs to assume the 'off' state; sturdy screw terminals for all external inputs and outputs; and the availability of versions to operate from different nominal input voltages and power supply sources.

Another range of Procon I/O boards designated PC-IO-DK/I is intended for heavier-duty industrial applications, being provided with inputs and outputs isolated to 4000V RMS, and plug-in output relays capable of switching



The basic Procon components necessary to convert your PC into a PLC: an interface card, cable and software package.

380V AC/125V DC at 10A (resistive load).

When initially released, the Procon boards were supplied with a 5.25" floppy disk containing a set of demonstration programs and utilities for use on any PC/XT/AT or compatible. As well as allowing the boards to be tested, these allowed the inputs to be sensed and the outputs controlled from most commonly-used programming languages — including GW-BASIC, IBM compiled BASIC, Borland's TurboBASIC and TurboPascal, Microsoft's QuickBASIC and the same firm's QuickC.

The latest version of this software also provides support for Microsoft's Professional Development System BASIC, V.7, and also documentation and support for controlling the 'Fischertechnik' range of experimental models and robots, using a single PC-IO-XX board.

Programming the boards in a language such as BASIC turns out to be very straightforward, as sensing the inputs involves little more than INP statements directed to the printer port address, while controlling the outputs similarly involves little more than OUT statements to the same port. And as BASIC already provides combinational logic functions like AND, OR and NOT, it isn't difficult to write the required control logic for many common PLC applications — particularly with the subroutines Procon has provided.

More recently, however, Procon has gone further than this. The company is now able to provide a dedicated and easy to use logic controller programming language, called (not surprisingly) 'PLC'. This allows you to program logic control sequences in graphical 'relay ladder logic' format — as was often used to work out the wiring of hard-wired PLCs, and is still used to program many dedicated microprocessor-based PLCs.

Graphical language

With relay ladder logic, the PLC program is 'written' and represented graphically as a series of symbols, as shown in the diagram. Each horizontal sequence represents a particular combinational logic function, while the program's sequential logic 'flow' can be represented by the vertical 'ladder' formed by successive horizontal steps. External input 'contacts' which are normally open (off) are represented as a symbol rather like a capacitor, while those that are normally closed (on) are represented by a similar symbol with a 'slash' between the contact 'plates'.

External output 'relays' are represented by a similar symbol with curved 'plates', again with a slash between them for outputs that are normally on rather than off. This symbol is also used for the 'controlled' or input aspect of an internal intermediate logic node, counter or timer element, whereas the 'controlling' aspect of these internal nodes is shown by the same symbol as an external input.

Using this simple graphical system, it's surprisingly easy to represent (and program) even fairly complex combinational logic functions. An AND function is produced just by showing the relevant input symbols wired in 'series', so that the function's output (over on the right-hand end) is activated only when all of the inputs are on. Similarly an OR function is produced by showing the relevant input symbols wired in 'parallel', so that any one alone can activate the output.

A number of separate 'horizontal' logic functions can be used to synthesise a complex combinational function. And as the output(s) from these combinational logic functions can be made the input(s) to others — either directly, or via an internal timer or counter element, it's also fairly easy to program quite fancy logic sequences...

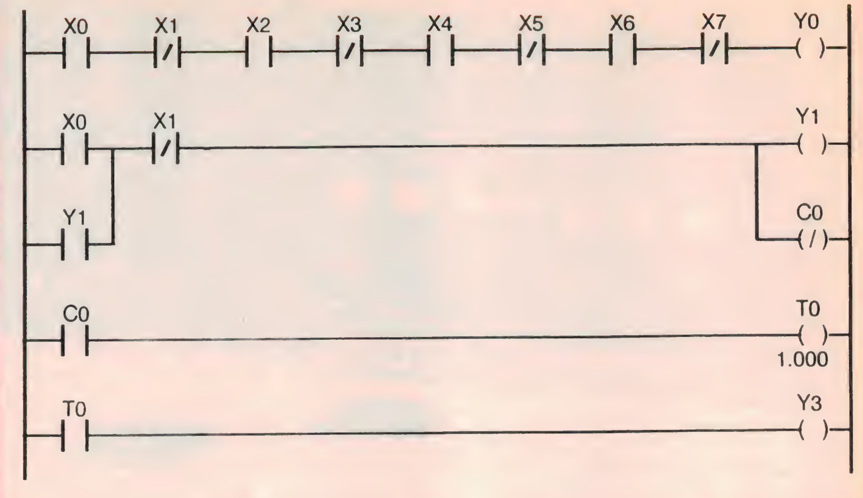
In short, programming a PLC in this 'language' is little more than drawing a fairly simple logic diagram, with annotations to identify external inputs, internal nodes and other functional elements like timers and counters, and external outputs.

Procon's PLC software is now avail-

able as Version 2.5, which runs programs at between 4 and 5 times faster than previous versions and provides such features as on-screen programming, program editing and real-time display of program status while running. It also allows you to edit programs while they're running, so that you can adjust time delays or correct logic errors 'on the run'.

In addition, PLC Version 2.5 now provides a memory resident program called 'IOSCAN' which can be used to vary the software's 'scanning' rate (i.e., how fast it scans the external inputs and outputs), up to 300 scans per second; a set of eight internal delay timers (0.1 second to 24 hours), and eight internal pulse down-counters (which can be preset from 0 up to 99,999); the ability to 'force' any internal/external logical input or output to either the on or off state, or alternatively 'unforce' it (with 'unforce all' and 'search' functions as well); the ability to operate with either mono or colour monitors; and a 'shell to DOS' function to allow both the PLC editor and the program being run to remain in memory, while another application is run.

There's also a 'run time' version of the program called 'PLCEXE', which can be used to run your program in background mode, while you're using the PC for something entirely different like word processing or running a spreadsheet.



What a PLC program looks like, in 'relay ladder logic'. Each horizontal line represents a combinational logic function, while the output of one function can be used as an input to others, to facilitate sequential logic.

Starter Pack

To help people get started in using their PC as a logic controller, Procon is currently marketing a 'PLC Starter Pack'. This consists of a PC-IO-NR-12VAC board, a 1m-long interconnecting cable with a DB-25 plug to match a standard PC printer port socket, one of Procon's modified printer port cards (which allows you to control up to 15 PC-IO-XX cards, if desired), the PLC software and an instruction manual. This sells for only $450, including tax, which seems good value for money.

Peter King of Procon was kind enough to send us one of his Starter Packs for evaluation, so we were able to try it all out.

With the PC-IO-NR-12VAC board you have a choice of three possible power sources — 9-12V AC, 9-16V unregulated DC, or regulated +5V DC which can be derived from the PC itself. In fact the 'PA- BUS' printer port card supplied as part of the Starter Pack has a banana socket added to the back mounting bracket, connected to the +5V rail on the PC's IO bus, for powering the card. However we elected to run it from a separate +12V DC supply, just to ensure that there were no problems with overload of the PC's supply.

Procon advises in the manual that it's advisable to use its own PA-BUS card port instead of an existing 'normal' printer port, not just because it can run 15 I/O boards and also has the +5V output socket, but also because it has pull-up resistors wired to all of the port input lines. Apparently some of the cards available don't provide pull-up resistors on all input lines, and this can cause problems — particularly if a long cable is used between the PC and the I/O card.

Despite this, and bearing in mind that the Starter Pack has only a single I/O board and uses a cable only 1m long, we decided to try using the PC's existing port. As it happens, everything worked fine, so there wasn't any need to use the other card.

First of all we tried accessing the I/O board's inputs and outputs from a few simple BASIC programs, just to get the feel of doing things this way. This worked without any problems, so we then fired up the PLC software and tried running some of Procon's demo programs.

These worked fine too, so then after consulting the manual we tried 'writing' a couple of simple programs using the PLC editor. Nothing fancy, just a few simple logic functions to get the hang of it. And these worked too, *eventually*.

I must confess that it took us a while to work out a few aspects of programming in PLC's relay ladder logic — especially things like how to put in vertical lines, to produce OR functions, and how to get the right result with a timer or pulse counter element. We eventually worked this out, but no thanks to the manual; this seemed to be written for the earlier version of PLC, and didn't really explain how to 'drive' the features that have been added for Version 2.5.

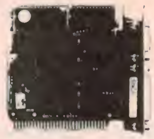
This apart, however, we found the PLC Starter Pack a nicely thought-out and well made package. It certainly provides an elegant way to use your PC as a logic controller, with the flexibility of being able to write programs in either a conventional 'computer' programming language like BASIC, or in relay ladder 'logic language' using PLC.

The latter option will just be somewhat easier, when Procon revises its manual to include the new features included in PLC Version 2.5...

Once this is done, the Starter Pack will provide an excellent way not only to learn about PLC's and their operation, but also to use your home or office PC as a logic controller.

For further information on either the PLC Starter Pack, the PC- IO-XX interface boards or the PLC software package, contact Procon Technology, PO Box 655, Mt Waverley 3149; phone (03) 807 5660. ■

Computer News and New Products



Libra to distribute Acer monitors

Acer Computers has given Libra Electronics the distribution rights for 'Acerview' colour monitors.

The first monitors available are Acerview 31, with 640 x 480 resolution in graphics mode, and Acerview 33 with a maximum resolution of 1024 x 768.

Both feature 14", 0.28mm dot pitch, high resolution, non-glare etched screens, and support modes ranging up from compatibility with VGA as the basic minimum.

Plans for even more advanced monitors are already in place.

For more information, circle 161 on the Reader Services Coupon or contact Libra Electronics, 552 Church St, North Parramatta 2151; phone (02) 890 1704.

Labtech expanded memory support

Labtech software for the DOS operating system is no longer restricted to its previous 640KB limit.

Most of the data structures associated with blocks or channels and all the buffers are now stored in LIM/EMS expanded memory.

This means that larger setups are possible even though the buffers are now limited to 16KB—larger than most buffers need to be. For the Labtech Notebook, Labtech Control and Labtech Acquire software packages, EMS memory makes possible larger setups with more free DOS memory for other applications.These packages are sold and supported by Priority Electronics.

For more information, circle 162 on the Reader Services Coupon or contact Priority Electronics, 23 Melrose St, Sandringham 3191; phone (03) 521 0266.

New IBM printer

IBM has released the ExecJet printer which is a very quiet (only 49dBA while running) wide-carriage printer using state-of-the-art ink-jet technology.

The printer boasts better-than-laser resolution of 360 x 360dpi, giving high resolution graphics and letter quality printing.

Combine this with its wide carriage and you have an ideal choice for many engineering drawings and architectural blueprints.

For more information, circle 163 on the Reader Services Coupon or contact IBM, PO Box 400, Pennant Hills 2120; phone (02) 634 9111.

IBM to market Lotus

IBM recently became a distributor of Lotus products throughout Australia and New Zealand.

This will allow IBM to market all Lotus products through its dealer networks as well as directly to its customers.

Lotus is well known for programs such as Lotus 1-2-3, Symphony, Freelance Graphics, Agenda and the Ami Professional Word Processor.

IBM provides a wide variety of hardware and operating system environments from PC to mainframe. The agreement should provide both companies the opportunities to build on each other's strengths.

Laser printer with 1000dpi

Lasermaster claims that, using the TurboRes printer controller software found on its Lasermaster 1000 printer, it can enhance the resolution by making the laser beam more agile.

A printer which usually works at 400dpi can produce a 1000 x 1000dpi image.

The printer's vertical resolution is limited to the 1/400th of an inch incremental steps that the printing drum takes as it rotates past the scanning laser beam.

But by moving the laser beam itself within these 1/400ths, higher resolution is possible. This allows half-height, quarter-height, or other fractional sized dots to be used to fill out the curves or diagonal lines of the printer characters.

This overcomes the need for a bulkier and more expensive mechanism to provide finer increments such as is found in high resolution photo imagesetters.

For more information, circle 166 on the Reader Services Coupon or contact Koseki Corporation, GPO Box 1628, Brisbane 4001; phone (07) 229 0466. ■

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